

**FINAL**  
FIFTH FIVE-YEAR REVIEW REPORT  
PICATINNY ARSENAL  
MORRIS COUNTY, NEW JERSEY

Prepared for:



Prepared by:



**US Army Corps  
of Engineers** ®  
Kansas City District

SEPTEMBER 2016

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MORRIS COUNTY, NEW JERSEY

Approved by:

  
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Signature

  
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Appendix 5 – Land Use Control Site Descriptions for Group of 11 and Land Use Monitoring Site Descriptions for 21 Site Group and 25 Site Group

## List of Acronyms

### List of Acronyms and Abbreviations

§	Section
µg/L	micrograms per liter
1,1-DCE	1,1-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
1,2,3,7,8-PeCDD	1,2,3,7,8-pentachlorodibenzo-p-dioxin
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
4,4'-DDE	4,4'-dichlorodiphenyldichloroethylene
4,4'-DDT	4,4'-dichlorodiphenyltrichloroethane
AOC	area of concern
ARAR	Applicable or Relevant and Appropriate Requirement
BERA	baseline ecological risk assessment
bgs	below ground surface
BSB	Bear Swamp Brook
CEA	Classification Exception Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CENWK	United States Army Corps of Engineers, Kansas City District
<i>cis</i> -DCE	<i>cis</i> -1,2-dichloroethene
COC	contaminant of concern
CT	carbon tetrachloride
CVOC	chlorinated volatile organic compound
CY	cubic yards
DBA	Drum Burial Area
DO	dissolved oxygen
DOC	dissolved organic carbon
DRMO	Defense Reutilization and Marketing Office
EA	EA Science and Technology
ECC	Environmental Chemical Corporation
EMCX	Environmental and Munitions Center of Expertise
ERA	ecological risk assessment
ERD	enhanced reductive dechlorination
ESC	Ecological Screening Criteria
ESD	Explanation of Significant Differences
EVO	emulsified vegetable oil
FFA	Federal Facility Agreement
FS	Feasibility Study
ft	feet
ft/day	feet per day



## List of Acronyms and Abbreviations

FYR	Five-Year Review
GIS	Geographic Information System
GPB	Green Pond Brook
HAL	health advisory level
HGMI	High Gradient Macroinvertebrate Index
HHRA	Human Health Risk Assessment
HI	Hazard Index
HRC	Hydrogen Release Compound
IC	institutional control
ICM	Improved Conventional Munitions
IRP	Installation Restoration Program
LOC	level of concern
LTM	long-term monitoring
LUC	land use control
LUCIP	Land Use Control Implementation Plan
MCL	maximum contaminant level
MEC	Munitions and Explosives of Concern
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNA	monitored natural attenuation
NBA	Northern Burial Area
NCP	National Contingency Plan
NFA	No Further Action
NJDEP	New Jersey Department of Environmental Protection
NJGWQS	New Jersey Groundwater Quality Standard
NJNRDCSCC	New Jersey Non-Residential Direct Contact Soil Cleanup Criteria
NPL	National Priorities List
O&M	operations and maintenance
ORP	oxidation-reduction potential
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene (also referred to as perchloroethene)
PEMS	Picatinny Environmental Management System
PRB	permeable reactive barrier
RA	Response Action
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RAR	Remedial Action Report
RAWP	Remedial Action Work Plan

## List of Acronyms and Abbreviations

RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDX	cyclotrimethylenetrinitramine
RFA	RCRA Facility Assessment
RG	remedial goal
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of influence
RSL	Regional Screening Level
SCL	site cleanup level
sf	square feet
SI	Site Investigation
SWQS	surface water quality standard
SVOCs	semi-volatile organic compounds
TCE	trichloroethene
TNT	2,4,6-trinitrotoluene
TOC	total organic carbon
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USEPA	United States Environmental Protection Agency
UXO	unexploded ordnance
VC	vinyl chloride
VI	vapor intrusion
VISL	vapor intrusion screening level
VOC	volatile organic compound
WWI	World War I
WWII	World War II
ZVI	zero-valent iron

## Executive Summary

The United States Army has prepared the fifth Five-Year Review (FYR) of remedial actions implemented at Picatinny Arsenal. Picatinny Arsenal is a 5,753 acre government-operated munitions research and development facility located in Morris County, New Jersey, approximately 40 miles west of New York City and four miles northeast of Dover, New Jersey. Established in 1880 by the U.S. War Department as a storage and powder depot, Picatinny Arsenal's mission has shifted to conducting and managing research development, life-cycle engineering, and support of other military weapons and weapon systems.

This FYR was prepared pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act § 121 and the National Contingency Plan. The FYR process is required because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure.

The triggering action for this statutory review is the date the United States Environmental Protection Agency concurred with the previous FYR which occurred in September 2011. This document represents the fifth FYR conducted for Picatinny Arsenal and encompasses the period from 2011 to 2016. As of 2015, Records of Decision have been signed for the 19 sites or groups of sites identified in **Table ES-1**, which qualifies them for inclusion in this FYR.

The purpose of the FYR is to evaluate the performance of the remedy and determine whether the remedy remains protective of human health and the environment and functions as intended based on the decision documents. Furthermore, the FYR assesses whether the remedy will continue to be protective in the future. It determines whether the exposure assumptions, toxicity data, cleanup levels and remedial action objectives, used at the time of the remedy selection are still valid and whether any other information has come to light that could call into question the protectiveness of the remedy. A site visit was conducted on December 1 and 2, 2015 as part of this review.

A number of remedial technologies have been selected and implemented at Picatinny Arsenal, including a permeable reactive barrier (PRB), *in-situ* bioremediation (ISB) via injections, monitored natural attenuation (MNA), long-term monitoring (LTM) of various media, soil removal actions, vegetative and impermeable covers, and land use and institutional controls (ICs). Groundwater use is restricted through the Classification Exception Area (CEA) established for all groundwater beneath the Picatinny Arsenal in both the bedrock and unconfined aquifers. While some sites require continued injections and/or regular performance monitoring, other sites simply require land use monitoring. For all sites, annual inspections are conducted to ensure land use has not changed and that site conditions are being maintained according to land use control (or monitoring) objectives established in the remedial designs (RDs). For all sites, ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures have remained active and effective in protecting human health.

This review concluded that with only two exceptions, the remedies in-place at Picatinny are protective of human health and the environment in the both short-term and the long-term as summarized in **Table ES-1**. The remedy for Area D (PICA-076) Groundwater was found to be protective in the short-term; however additional data collection and evaluation are recommended to better understand the long-term effectiveness of the PRB in protecting Green Pond Brook (GPB), as discussed below. The determination of protectiveness for Group 1 Sites (PICA-079) was deferred until the Army completes

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the Lake Picatinny Feasibility Study (FS) which will determine whether explosives in Group 1 Sites groundwater discharging to Lake Picatinny pose unacceptable risks to the environment.

**Table ES-1: Protectiveness Determination Summary for Sites in the Fifth Five-Year Review**

No.	Site / Site Group Name	Protectiveness Determination		Other Follow-up Recommendation <sup>1</sup> Provided?
		Short-term	Long-term	
1	Site 23 (PICA-065) – Post Farm Landfill	Yes	Yes	--
2	Site 20/24 (PICA-066) – Former Pyrotechnic Testing Range/ Sanitary Landfill	Yes	Yes	--
3	Site 25/26 (PICA-067) – Former Sanitary Landfill/ Dredge Pile	Yes	Yes	--
4	Area D (PICA-076) Groundwater	Yes	No	Yes
5	Area E (PICA-077) Groundwater	Yes	Yes	Yes
6	Site 180 (PICA-093) – Former Waste Burial Area	Yes	Yes	--
7	Green Pond Brook and Bear Swamp Brook (PICA-193)	Yes	Yes	--
8	Group of 11 Sites (PICA-020)	Yes	Yes	--
9	Site 61/104 (PICA-102) – Former Waste Dumps and Chemical Laboratories	Yes	Yes	--
10	Area B (PICA-205) Groundwater	Yes	Yes	Yes
11	Site 31/101 (PICA-072) – Former DRMO Yard	Yes	Yes	--
12	Area C (PICA-206) Groundwater	Yes	Yes	Yes
13	Group 3 Sites (PICA-008) Groundwater and Surface Water	Yes	Yes	Yes
14	Group 1 Sites (PICA-079)	Protectiveness Deferred		Yes
15	Site 34 (PICA-002) - Former Lower Burning Grounds	Yes	Yes	Yes
16	Site 78 (PICA-013) Groundwater and Surface Water	Yes	Yes	--
17	Mid-Valley (PICA-204) Groundwater	Yes	Yes	Yes
18	25 Site Group	Yes	Yes	--
19	21 Site Group	Yes	Yes	--

--Not applicable

DRMO = Defense Reutilization and Marketing Office

<sup>1</sup>Recommendation not directly tied to protectiveness, but intended to improve the effectiveness, efficiency, or level of confidence in the existing remedy.

### **Long-Term Protectiveness of Area D (PICA-076) Groundwater Remedy**

The remedy at Area D (PICA-076) Groundwater includes MNA of chlorinated volatile organic compounds (CVOCs) in groundwater and a PRB to protect the surface water in GPB. The PRB was designed to reduce CVOC mass such that contaminants discharging to surface water remain below site cleanup levels (SCLs). The following observations are early indicators that 1) the groundwater may be flowing to the southwest of the PRB due to reduced permeability in the PRB or natural plume migration and 2) PRB treatment efficiency may be declining:

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1. Observation of trichloroethene (TCE) in lateral monitoring well located on the southwest side of the PRB
2. Intermittent detections of TCE in surface water immediately downgradient of the PRB
3. Increases in CVOC concentrations within piezometers installed within the southwest portion of the PRB

As a result of these observations, this FYR recommends increased monitoring of PRB wells and surface water and a thorough evaluation of PRB performance as a part of the next annual monitoring report. To support this evaluation, **Section 8.0** recommends collecting additional data such as water levels and water quality samples from a denser, expanded set of monitoring wells.

This FYR also recommends defining areas with high concentrations of CVOCs upgradient of the PRB where focused ISB can be conducted to reduce the MNA timeframe and ultimately mass flux to the PRB. ISB has been implemented at Picatinny at Area B Groundwater, Group 3 sites, and Mid-Valley. Findings, recommendations and a feasibility level cost estimate will be summarized in a technical memorandum.

**Protectiveness Determination Deferred at Group 1 Sites (PICA-079)**

Groundwater, surface water, and sediment monitoring results associated with the Group 1 Sites (PICA-079) indicate explosives may be discharging to Lake Picatinny above SCLs as discussed in **Section 18**. While there is currently no outward evidence of ecological harm, the Army is currently conducting the Lake Picatinny FS to determine if there are residual risks that have not been adequately addressed by the actions at Group 1 Sites (PICA-079). The determination of protectiveness for human health and the environment at Group 1 Sites (PICA-079) is therefore being deferred until completion of the Lake Picatinny FS (estimated in December 31, 2017). Once this information is available, a protectiveness determination will be made in the form of an addendum to the FYR Report.

**Other Recommendations**

This FYR identified the following recommendations (not directly tied to protectiveness) to improve the effectiveness, efficiency, or level of confidence in the existing remedy.

**Table ES-2: Other Recommendations Identified in the Fifth Five-Year Review**

Site / Site Group Name	Other Recommendations
Area D (PICA-076) Groundwater	During the next two regularly scheduled sampling events, samples collected from the wellhead of potable water supply well D-PW-131 should be analyzed for 1,4-dioxane.
Area E (PICA-077) Groundwater	The next groundwater monitoring event should include analysis of 1,4-dioxane at select wells near the source area and at select wells immediately downgradient of the source area.
Area B (PICA-205) Groundwater	A few years of additional monitoring, beyond the 7 years estimated in the Record of Decision, will be needed to meet Remedial Action Objectives
Area C (PICA-206) Groundwater	Groundwater constituents of concern, arsenic and lead, are naturally occurring metals within local bedrock. Recommend summarizing low level detections of arsenic and lead at Area C and Picatinny and then comparing to regional concentrations in groundwater to determine if concentrations are due to geologic conditions.

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Group 3 Sites (PICA-008) Groundwater and Surface Water	The next groundwater monitoring event should include analysis of 1,4-dioxane at select wells near the source area and at select wells immediately downgradient of the source area.
Group 1 Sites (PICA-079)	Additional information may be needed to determine if the remedy will be able to achieve SCLs within the estimated timeframe of 30 to 40 years. The Army may need to conduct additional remedial timeframe estimates every two years until such time as site groundwater data demonstrate a decreasing trend. During the next sampling event, a subset of monitoring wells should be sampled for perchlorate and reported in the annual report.
Site 34 (PICA-002) - Former Lower Burning Grounds	As part of the next statistical analysis and optimization of the long-term monitoring program, the list of metals (currently 23 metals) should be reviewed for potential reductions. As an example, metals that reflect contaminants of concern in the soil or associated with Site 34 may be retained, while others discontinued.
Mid-Valley (PICA-204) Groundwater	During the next two regularly scheduled sampling events, samples collected from the wellhead of potable water supply well PW-302D should be analyzed for 1,4-dioxane. Opportunities were identified that may support optimization of the enhanced reductive dechlorination (ERD) injection program ( <b>Section 21.5.1.2</b> ). During the next sampling event, a subset of monitoring wells should be sampled for perchlorate and reported in the annual report.

Additional information pertaining to remedial actions, progress since the last FYR process, technical assessments, issues and discussions, recommendations, and protectiveness statements are presented on a site-specific basis in chronological order of remedy implementation starting in **Section 5.0** of this document.

## Five-Year Review Summary Form

<b>SITE IDENTIFICATION</b>		
<b>Site Name:</b> Picatinny Arsenal		
<b>EPA ID:</b> NJ3210020704		
<b>Region:</b> 2	<b>State:</b> NJ	<b>City/County:</b> Dover/Morris County
<b>SITE STATUS</b>		
<b>NPL Status:</b> Final		
<b>Multiple OUs*</b> Yes	<b>Has the site achieved construction completion?</b> No	
<b>REVIEW STATUS</b>		
<b>Lead agency:</b> Other Federal Agency: Department of Army		
<b>Author name (Federal or State Project Manager):</b> Ted Gabel, Project Manager		
<b>Author affiliation:</b> Department of Army		
<b>Review period:</b> 11/2015 – 09/2016		
<b>Date of site inspection:</b> 12/1/2015-12/2/2015		
<b>Type of review:</b> Statutory		
<b>Review number:</b> 5		
<b>Triggering action date**:</b> September 30, 2011 (Previous Five-Year Review)		
<b>Due date (five years after triggering action date):</b> September 30, 2016		

\*OU = operable unit

\*\*In accordance with updated guidance<sup>1</sup> for FYRs at Federal Facilities, FYRs following fiscal year (FY) 2011, will be due every five years from the FYR report due date established in FY 2011, regardless of the signature date of future FYRs.

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<sup>1</sup> Federal Facilities Restoration and Reuse Office. *Program Priorities for Federal Facility Five-Year Review*. Memorandum to Superfund National Policy Managers, Regions 1-10. 1 Aug. 2011.

Federal Facilities Restoration and Reuse Office. *Correction to the Memorandum "Program Priorities for Federal Facility Five-Year Review"*. Memorandum to Superfund National Policy Managers, Regions 1-10. 22 Feb. 2012.

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Issues/Recommendations Identified in the Five-Year Review	
Area D (PICA-076) Groundwater	
<p>Early indicator of a Potential Issue: Based on TCE detections at surface water monitoring location D-SW-4 in Green Pond Brook in 2014, in well D-PRB-9 (located on southwestern end of PRB) in 2015 and increased concentrations of TCE and cis-1,2-dichloroethene (cis-DCE) at D-PZ-1 and degradation products (D-PZ-2), observed within the PRB, the PRB may be losing treatment efficiency and/or the plume may be moving to the south of the PRB, due to natural causes or reduced PRB permeability. Recommendation: Recommend increasing the monitoring frequency of the PRB wells and the surface water from annually to semi-annually to monitor PRB performance, and conducting a thorough evaluation of PRB performance as a part of the next annual monitoring report. Section 8.0 of this report recommends collection of additional data such as water levels and water quality samples from a denser, expanded set of monitoring wells. In addition, Section 8.0 recommends defining areas with high concentrations of CVOCs upgradient of the PRB where focused in situ bioremediation can be conducted to reduce the MNA timeframe and ultimately the mass flux to the PRB. Findings, recommendations and a feasibility level cost will be summarized in a technical memorandum.</p>	
Group 1 Sites (PICA-079)	
<p>Issue: Groundwater, surface water, and sediment monitoring results indicate explosives in groundwater may be discharging to Lake Picatinny above SCLs. Recommendation: Complete the Lake Picatinny FS which assesses whether unacceptable risks are present and then reevaluate the protectiveness of the current Group 1 Sites remedy. The determination of protectiveness for human health and the environment is being deferred until further the Lake Picatinny FS is completed (estimated by December 31, 2017). Once complete, a protectiveness determination should be made in the form of an addendum to the FYR Report.</p>	

Issues and Recommendations Identified in the Five-Year Review:				
Area D (PICA-076) Groundwater				
Area D (PICA-076) Groundwater	Issue Category: Remedy Performance			
	Issue: Potential reduced effectiveness of PRB			
	Recommendation: Increase monitoring frequency of PRB wells and surface water and further evaluate PRB performance as part of next annual monitoring report. Defining areas upgradient of PRB for performing ISB.			
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Federal Facility	EPA	September 2021
Group 1 Sites (PICA-079)				
Group 1 Sites (PICA-079)	Issue Category: Remedy Performance			
	Issue: Potential risks associated with explosives in groundwater discharging to Lake Picatinny are currently being evaluated in the Lake Picatinny FS.			



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<b>Recommendation:</b> Complete the Lake Picatinny FS and then reevaluate the protectiveness of the Group 1 Sites remedy.				
Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
NA	NA	Federal Facility	EPA	September 2021

**Protectiveness Statement**

Operable Unit: Site 23 (PICA-065) – Post Farm Landfill	Protectiveness Determination: Protective
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**Protectiveness Statement:**

The remedy at Site 23 (PICA-065) – Post Farm Landfill is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Annual groundwater sampling under the LTM program has been performed, in accordance with the ROD and RD. The LTM groundwater monitoring program and statistical analyses have shown that contaminants of concern (COCs) concentrations at the site have remained below SCLs, with the exception of cadmium at monitoring well DM23-03. The facility-wide CEA restricts access to and use of groundwater at PICA. Land use control (LUC) inspections have occurred annually to ensure the integrity of the vegetative cap, fencing, and signage is being maintained and to verify land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: Site 20/24 (PICA-066) – Former Pyrotechnic Testing Range/ Sanitary Landfill	Protectiveness Determination: Protective
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**Protectiveness Statement:**

The remedy at the Pyrotechnics Range and Sanitary Landfill (PICA-066, Site 24) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Soils with COCs above SCLs have been excavated and either disposed off-site or consolidated beneath the vegetative cap. The vegetative cap has prevented receptor exposure. Annual LUC inspections have ensured the integrity of the vegetative cap, fencing, and signage is being maintained and has verified that land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit:	Protectiveness Determination: Protective
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Site 25/26 (PICA-067) – Former Sanitary Landfill/ Dredge Pile	
<p>Protectiveness Statement:</p> <p>The remedy at the Former Landfill and Dredge Pile (PICA-067, Site 25) is protective of human health and the environment.</p> <p>The following elements of the remedy have ensured that the RAO (to prevent exposure to contaminated soils impacted by COCs above SCLs) is being met. Installation of a vegetative soil cover and implementation of LUCs has prevented receptor exposure. Annual LUC inspections have ensured the integrity of the soil cover and signage is being maintained and has verified that land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active.</p>	
Protectiveness Statement	
Operable Unit: Area D (PICA-076) Groundwater	Protectiveness Determination: Short-term Protective
<p>Protectiveness Statement:</p> <p>The remedy at Area D (PICA-076) Groundwater currently protects human health and the environment.</p> <p>The following elements of the remedy have ensured that RAOs are being met. Groundwater and surface water monitoring have been conducted consistent with the RD to evaluate PRB effectiveness and protection of surface water as well as COC trends from within and near the extent of the Area D groundwater plume. Annual LUC inspections, sampling of potable water supply well D-PW-131, wellhead treatment of D-PW-131 and operation in compliance with New Jersey Department of Environmental Protection (NJDEP) drinking water permit, and maintenance of the facility-wide CEA restricting groundwater use ensures LUCs remain effective at restricting potential exposure to contaminated groundwater and surface water. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.</p> <p>However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: increased monitoring of PRB wells and surface water and a thorough evaluation of PRB performance as a part of the next annual monitoring report, as well as, evaluating use of enhanced bioremediation upgradient of PRB. To support this evaluation, supplemental data collection is recommended, as outlined in <b>Section 8</b> of this FYR.</p>	
Protectiveness Statement	
Operable Unit: Area E (PICA-077) Groundwater	Protectiveness Determination: Protective
Protectiveness Statement:	

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The remedy at Area E (PICA-077) Groundwater is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. MNA sampling of groundwater and surface water is currently being conducted annually, in accordance with the RD and program adjustments documented in the annual reports. The facility-wide CEA restricts access to and use of groundwater at Picatinny Arsenal. Annual LUC inspections ensure the integrity of monitoring systems is maintained, no unauthorized intrusive activities have occurred, existing ground covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: Site 180 (PICA-093) – Former Waste Burial Area	Protectiveness Determination: Protective
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**Protectiveness Statement:**

The remedy at Site 180 (PICA-093) - Former Waste Burial Area is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Construction of a soil cover at Site 34 Lower Burning Ground extended into the southwestern portion of Site 180 and included the waste piles and buried debris areas within Site 180. Annual LUC inspections have verified that signs remain in place, no unauthorized intrusive activities have occurred, existing surface covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective. As stated in the ROD, possible ecological risks are present at the site; however remediation could adversely impact high-value wetlands and result in more damage to the environment.

**Protectiveness Statement**

Operable Unit: Green Pond Brook and Bear Swamp Brook (PICA-193)	Protectiveness Determination: Protective
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**Protectiveness Statement:**

The remedy at Green Pond and Bear Swamp Brooks (PICA-193) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Chemical monitoring within sediment and surface water and biological monitoring have been conducted within Region 2, 3, and 4, in accordance with the LTM program outlined in the RD and program adjustments documented in the annual reports. A series of removal actions have improved sediment quality, and the LTM program has been used to identify areas where sediment removal is beneficial. Annual LUC inspections have been effective in limiting exposure to site contaminants. Annual site inspections were conducted to confirm continued compliance with all LUC objectives which include prohibiting the development of property within 25 feet of Green

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Pond Brook/Bear Swamp Brook and prohibiting fishing, swimming, and/or recreational activities in and around Green Pond Brook/Bear Swamp Brook. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: Group of 11 Sites (PICA-020)	Protectiveness Determination: Protective
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**Protectiveness Statement:**  
The remedy at the Group of 11 Sites (PICA-020, Site 19) is protective of human health and the environment.

The remedy's RAO to maintain current land use (industrial) and current ICs is being met. Annual land use monitoring inspections have verified that signs remain in place, no unauthorized intrusive activities have occurred, existing surface covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: Site 61/104 (PICA-102) – Former Waste Dumps and Chemical Laboratories	Protectiveness Determination: Protective
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**Protectiveness Statement:**  
The remedy at Site 61/104 (PICA-102) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Contaminated soils were excavated and disposed off-site. Established vegetation is being used as an engineering control to limit exposure. Annual LUC inspections have verified that signs remain in place, no unauthorized intrusive activities have occurred, existing surface covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: Area B (PICA-205) Groundwater	Protectiveness Determination: Protective
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**Protectiveness Statement:**  
The remedy for Area B (PICA-205) Groundwater is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Historical injection of carbon solution (*in-situ* enhanced bioremediation) has resulted in significant progress towards meeting RAOs. Performance and annual groundwater and surface water monitoring have been completed, consistent with the RD. The facility-wide CEA restricts

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access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring wells, injection wells, and signs are maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: Site 31/101 (PICA-072) – Former DRMO Yard	Protectiveness Determination: Protective
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**Protectiveness Statement:**

The remedy at Site 31/101 (PICA-072) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Contaminated soils were excavated and either disposed off-site or consolidated on-site beneath a cover. A soil and asphalt cover were installed as an engineering control to limit exposure. Annual LUC inspections have verified that signs remain in place, no unauthorized intrusive activities have occurred, the vegetative and asphalt covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: Area C (PICA-206) Groundwater	Protectiveness Determination: Protective
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**Protectiveness Statement:**

The remedy for Area C (PICA-206) Groundwater is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. The LTM program has been conducted in accordance with the LTM program and exit strategy outlined in the RD. The monitoring program has been reduced from 32 to 26 sampling locations, and in most wells analytes reduced to three COCs (vinyl chloride, arsenic and lead). To date no contaminants have exceeded the trigger action for a more aggressive remedial approach. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring systems and signs has been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: Group 3 Sites (PICA-008) Groundwater and Surface Water	Protectiveness Determination: Protective
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**Protectiveness Statement:**

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The remedy for Group 3 Sites (PICA-008) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Injections of carbon solution have made progress towards reducing COC mass in the surficial aquifer and as of the 2015 event, concentrations are below the threshold values for carbon tetrachloride (CT) (50 µg/L) and TCE (10 µg/L) that require active treatment or injections. Surface water results have been below SCLs for the duration of this review period. Performance and annual groundwater and surface water monitoring have been completed, consistent with the RD. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring and injection systems has been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: Group 1 Sites (PICA-079)	Protectiveness Determination: Deferred
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**Protectiveness Statement:**

A protectiveness determination of the remedy for Group 1 Sites (PICA-079) cannot be made at this time until further information is obtained.

There is currently no outward evidence of ecological harm; however, the Army is conducting the Lake Picatinny FS to determine if there are any residual risks that have not been adequately addressed by the actions at Group 1 sites. The determination of protectiveness for human health and the environment is being deferred until further information is obtained. Further information will be obtained by continued groundwater monitoring as well as quarterly monitoring of surface water and sediment and completion of the FS for Lake Picatinny. It is expected that this information will be obtained by December 31, 2017, at which time a protectiveness determination will in the form of an addendum to the FYR Report.

Excavation of explosives impacted soil and monitoring of groundwater, surface water, and sediment has been conducted, in accordance with the RD and program adjustments documented in the annual reports. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure that monitoring systems and signs have been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective. ICs currently assure protection of human health.

**Protectiveness Statement**

Operable Unit: Site 34 (PICA-002) - Former Lower Burning Grounds	Protectiveness Determination: Protective
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**Protectiveness Statement:**

The remedy for the Former Lower Burning Grounds (PICA-002) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. The primary component of the remedy, the hybrid soil/asphalt cover, has been installed, vegetation established, and the stormwater management system modified to adjust to observed field conditions. LTM of groundwater and surface water has been implemented per the program outlined in the RD. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections have been conducted to ensure the soil and asphalt cover are maintained, the stormwater management system is functioning as designed, monitoring systems and signs have been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

#### Protectiveness Statement

Operable Unit: Site 78 (PICA-013) Groundwater and Surface Water	Protectiveness Determination: Protective
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#### Protectiveness Statement:

The remedy for Site 78 (PICA-013) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. The MNA program has been conducted as outlined in the RD. As of the 2015 sampling event, COCs above SCLs are only present at one of the four monitoring wells (VC at 78MW-6) and results from all three surface water sampling locations have been below SCLs in 2014 and 2015. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring systems has been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

#### Protectiveness Statement

Operable Unit: Mid-Valley (PICA-204) Groundwater	Protectiveness Determination: Protective
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#### Protectiveness Statement:

The remedy for Mid-Valley Groundwater (PICA-204) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Performance and groundwater and surface water monitoring have been completed, consistent with the RD. MNA groundwater trends and results associated with the VOC and RDX plumes as well as the LTM programs were found to be generally stable or consistent with previous results. ERD injections have been conducted, consistent with the RD; performance monitoring results show some instances where reducing conditions were established and treatment is occurring but also highlight areas where optimization may improve the effectiveness of injections. The facility-

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wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring and injection networks and signs are maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

**Protectiveness Statement**

Operable Unit: 25 Site Group	Protectiveness Determination: Protective
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**Protectiveness Statement:**  
The remedy at the 25 Site Group is protective of human health and the environment.

All of the sites within the 25 Site Group require NFA with annual documentation showing the land use has not changed from what was assumed in the ROD. Annual land use inspections have demonstrated that land use has not changed. ICs enforced by the Army, such as land use restrictions, remain active and effective.

**Protectiveness Statement**

Operable Unit: 21 Site Group	Protectiveness Determination: Protective
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**Protectiveness Statement:**  
The remedy at the 21 Site Group (PICA-096) is protective of human health and the environment.

All of the sites within the 21 Site Group require NFA with annual documentation showing the land use has not changed from what was assumed in the ROD. Annual land use inspections have demonstrated that land use has not changed. ICs enforced by the Army, such as land use restrictions, remain active and effective.



## 1.0 Introduction

The purpose of the five-year review (FYR) is to evaluate the performance of the remedy and determine whether the remedy remains protective of human health and the environment and functions as intended based on the decision documents. Furthermore, the FYR assesses whether the remedy will continue to be protective in the future. It determines whether the exposure assumptions, toxicity data, cleanup levels and remedial action objectives (RAOs), used at the time of the remedy selection are still valid and whether any other information has come to light that could call into question the protectiveness of the remedy.

The FYR is a statutory requirement for Picatinny Arsenal pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section (§) 121(c) and the National Contingency Plan (NCP). CERCLA § 121(c), as amended, states the following:

*If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

In the NCP implementing regulations, 40 Code of Federal Regulations § 300.430(f)(4)(ii), the United States Environmental Protection Agency (USEPA) provided the following interpretation:

*If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The United States Army Corps of Engineers (USACE), under contract to the U.S. Army Environmental Command (USAEC), conducted the fifth FYR of the remedial actions implemented at Picatinny Arsenal, located approximately four miles north of the City of Dover in Morris County, New Jersey.

This review was conducted from November 2015 through April 2016 by the USACE, Kansas City District (CENWK). This report documents the results of that review. The triggering action for this statutory review is the date the USEPA concurred with the previous FYR, which occurred in September 2011. The FYR is required because hazardous substances, pollutants, or contaminants remain at the sites above levels that allow for unlimited use and unrestricted exposure. This FYR includes the review of site conditions and site data available as of December 31, 2014, and when available, validated data from 2015.

### 1.1 Sites Reviewed

The 19 sites or groups of sites (**Table 1-1**) are included in this FYR because they have signed Records of Decision (RODs) and conditions that do not allow for unlimited use and unrestricted exposure as of December 31, 2014. Since environmental investigations and restoration activities began at Picatinny, sites

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have been consolidated, prioritized, and regrouped for reasons discussed in **Section 4.4**. As a result, three different tracking systems are associated with each of the 19 groups of sites. These include the 1) Site or Group of Sites name, 2) PICA number (Army tracking system), and 3) Remedial Investigation (RI) Concept Site Number. For reviewing clarity, each site will be introduced with all three nomenclatures; however once introduced, the group or site name will assume the primary title. The sites are ordered chronologically, according to ROD signature date, from oldest to newest. A key linking the group and site names to the PICA and RI Concept Site Numbers is presented in **Appendix 1, Table 1-2**.

**Table 1-1: List of Sites in Fifth Five-Year Review**

Report Section	Site / Site Group Name
5.0	Site 23 (PICA-065) – Post Farm Landfill
6.0	Site 20/24 (PICA-066) – Former Pyrotechnic Testing Range/ Sanitary Landfill
7.0	Site 25/26 (PICA-067) – Former Sanitary Landfill/ Dredge Pile
8.0	Area D (PICA-076) Groundwater
9.0	Area E (PICA-077) Groundwater
10.0	Site 180 (PICA-093) – Former Waste Burial Area
11.0	Green Pond Brook and Bear Swamp Brook (PICA-193)
12.0	Group of 11 Sites <sup>1</sup> (PICA-020)
13.0	Site 61/104 (PICA-102) – Former Waste Dumps and Chemical Laboratories
14.0	Area B (PICA-205) Groundwater
15.0	Site 31/101 (PICA-072) – Former DRMO Yard
16.0	Area C (PICA-206) Groundwater
17.0	Group 3 Sites (PICA-008) Groundwater and Surface Water
18.0	Group 1 Sites (PICA-079)
19.0	Site 34 (PICA-002) - Former Lower Burning Grounds
20.0	Site 78 (PICA-013) Groundwater and Surface Water
21.0	Mid-Valley (PICA-204) Groundwater
22.0	25 Site Group
23.0	21 Site Group <sup>2</sup>

<sup>1</sup>Formerly referred to as The Group of 13 Sites

<sup>2</sup>The 21 Site Group was signed by the Garrison Commander on December 4, 2014 but signed on March 2, 2015 by the USEPA Region 2 Director of Emergency and Remedial Response Division.

## 1.2 Report Organization

Due to the complexity and number of individual sites addressed in this report, the report organization deviates from the FYR Report Guidance (USEPA, 2001) to provide a more readable document by summarizing facility-wide information upfront and site-specific information within individual sections. Required information has been grouped by site in order to present a complete review and provide recommendations in one place. The chart below presents the report organization according to FYR guidance and identifies where the appropriate information can be found in this report.

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Guidance Organization	Five-Year Report Organization
1. Introduction	<b>Section 1.</b> Introduction Consistent with guidance
2. Site Chronology	<b>Section 2.</b> Facility-wide chronology. Specific chronology is included in individual sections.
3. Background -Site Location -Physical Characteristics -Land and Resource Use -History of Contamination -Initial Response -Basis for Taking Action	<b>Section 4.</b> Facility-wide Background and Land Use Controls Summarizes facility-wide information and institutional controls applicable to entire Facility. Site-specific background are presented within individual sections.
4. Remedial Action -Remedy Selection -Remedy Implementation -System Operation/O&M	<b>Sections 5-23.</b> Individual site sections. Site-specific basis for taking action included.
5. Progress Since Last Review	<b>Sections 5-23.</b> Individual site sections
6. Five-Year Review Process -Review Team Members -Community Involvement -Document Review -Data Review -Site Inspections -Interviews	<b>Section 3. Five-Year Review Process</b> Each of the components listed under guidance is included in this section with the exception of: <ul style="list-style-type: none"> <li>- Documents relevant to all sites listed in <b>Section 3.</b></li> <li>- Site-specific documents listed in <b>Sections 5-23.</b></li> <li>- Data Review is summarized within site-specific sections.</li> <li>- Where applicable, site-specific inspections and interviews may be discussed in more detail within <b>Sections 5-23.</b></li> <li>- A discussion of the method used to evaluate the validity of previous human health risk assumptions is included within the section.</li> </ul>
7. Technical Assessment -Question A -Question B -Question C	<b>Sections 5-23.</b> Individual site sections
8. Issues	<b>Sections 5-23.</b> Individual site sections
9. Recommendations and Follow-up Actions	<b>Sections 5-23.</b> Individual site sections
10. Protectiveness Statement	<b>Sections 5-23.</b> Individual site sections <b>Section 24.</b> Site-wide Protectiveness statement
11. Next Review	<b>Section 25.</b> Next Review
	<b>Section 26.</b> References

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A typical site-specific section is organized in the following manner:

<b>1.0 Individual Section Organization (Sections 5-23)</b>
<b>1.1 Site Background:</b> <ul style="list-style-type: none"><li>- Site Location</li><li>- Physical Characteristics (if discussion beyond Facility-wide description is merited)</li><li>- Land and Resource Use (if different from Facility-wide description)</li><li>- History of Contamination</li><li>- Site Chronology</li><li>- Initial Response</li><li>- Basis for Taking Action</li></ul>
<b>1.2 Remedial Actions:</b> <ul style="list-style-type: none"><li>- Remedy Selection</li><li>- Remedy Implementation</li><li>- System Operation/O&amp;M</li></ul>
<b>1.3 Progress Since Last Five-Year Review</b>
<b>1.4 Document and Data Review</b> <ul style="list-style-type: none"><li>- Documents Reviewed</li><li>- Data Review and Evaluation</li></ul>
<b>1.5 Technical Assessment</b> <ul style="list-style-type: none"><li>- Question A</li><li>- Question B</li><li>- Question C</li></ul>
<b>1.6 Issues</b>
<b>1.7 Recommendations and Follow-up Actions</b>
<b>1.8 Protectiveness Statement</b>

## 2.0 Site Chronology

Significant site or installation-wide events are presented in **Table 2-1**. A site-specific chronology of events is included in individual sections

**Table 2-1: Chronology of Site Events**

Event	Year
Installation Assessment completed by the United States Army Toxic and Hazardous Materials Agency (USATHAMA)	1976, 1981
Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) completed by the New Jersey Department of Environmental Protection (NJDEP)	1987
Site Investigation (SI) completed by Army	1989
Area D Groundwater Interim Action ROD signed	1990
Picatinny Arsenal placed on National Priority List (NPL)	1990
Federal Facility Agreement signed between the Department of the Army-Picatinny Arsenal and the USEPA	1991
Remedial Investigation (RI) Concept Plan completed	1991
Lagoons and dry well associated with Building 24 removed under RCRA	1991
Area D Groundwater Interim Action Remedy commenced	1992
Building 95 Impoundments removed	1992
Post Farm Landfill (Site 23) Removal Action	1993
Lead Removal Action – Site 35/ Building 1363A and Site 167/Building 1373	1995
Wharton Waterline Extension	1996
<b>First Five-Year Review</b>	1996
Guncotton Line Investigation Removal Action – Site 16	2000
<b>Second Five-Year Review</b>	2001
Tetryl Pits Removal Action – Site 17	2002
Site 20/24 (Pyrotechnic Testing Range/Sanitary Landfill) ROD signed	2002
Site 20/24 Remedial Action Construction commenced	2002
Clarification of the Statement of Protectiveness Amending the Second Five-Year	2002
Polychlorinated Biphenyl (PCB) Removal Action at Site 122/Building 60	2003
Bear Swamp Brook Sedimentation Basin Removal	2004
Area D Groundwater Final ROD signed	2004
Site 23 (Post Farm Landfill) ROD signed	2004
Site 20/24 Remedial Action Construction completed	2004
Lead Sites Removal Action	2004
Green Pond Brook and Bear Swamp Brook ROD signed	2005
Site 34 (Burning Ground) ROD signed	2005
Facility-Wide Removal of Sumps and Dry Wells	2005
<b>Third Five-Year Review Signed</b>	2006
Area D Groundwater Final Remedy (Permeable Reactive Barrier) installed	2007
Site 25/26 (PICA-067), Site 180 (PICA-093), Area E Groundwater (PICA-077), ROD	2007
Site 23 (PICA-65), Site 25/26 (PICA-067), Site 180 (PICA-093), Area E Groundwater (PICA-77), Green Pond Brook (PICA-193), Group of 13* Site (PICA-20) RAs completed	2007
Group of 13* Site (PICA-20) ROD signed	2008
Site 31/101 (PICA-072) and Area B Groundwater (PICA-205) ROD signed	2009
Area C Groundwater (PICA-206) ROD Signed	2009
Area C (PICA-206) Groundwater Response Action (RA) commenced	2009
Group 1 (PICA-079) and Group 3 (PICA-008) RODs signed	2010

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Group 1 (PICA-079) and Group 3 (PICA-008) RAs commenced	2010
<b>Fourth Five-Year Review Signed</b>	2011
RI Concept Plan Site 78 (PICA-013) ROD signed	2011
RI Concept Plan Site 78 (PICA-013) RA implemented	2011
Mid-Valley Groundwater (PICA-204) ROD signed	2012
Mid-Valley Groundwater (PICA-204) RA commenced	2013
25 Site Group ROD signed	2014
21 Site Group (PICA-096) ROD signed	2014

\*Group of 13 renamed as Group of 11, as discussed in **Section 12.0**

### **3.0 Five-Year Review Process**

#### **3.1 Review Team Members**

The fifth FYR effort included the following team members:

- CENWK:
  - Erin Hauber, Technical Lead
  - Kenneth Kamp, Project Engineer
  - Greg Hattan, Geologist
  - Janet Mathews-Flynn, Hydrogeologist
  - Dave Twigg and Dave Daniel, Risk Assessors
- Support and/or review from:
  - Ted Gabel, Picatinny Arsenal Environmental Restoration Manager
  - USAEC
  - USACE Environmental and Munitions Center of Expertise (EMCX)
  - EA Science and Technology (EA)

#### **3.2 Community Involvement**

A newspaper notice was placed in The Star Ledger and the Daily Record on January 12, 2016 and January 13, 2016, respectively, to notify the community that the FYR process is underway. A notice was also published in The Picatinny Voice on November 27, 2015. On November 19, 2015, EPA Region 2 posted a notice on its website indicating it would be reviewing site cleanups and remedies at 32 Superfund sites and four federal facilities in New York and New Jersey, including the Picatinny Arsenal. Verification of publication for these notifications and postings is included in **Appendix 3**. The Picatinny Arsenal's Environmental Restoration Advisory Board (RAB) meetings are used to inform and discuss the progress of environmental restoration with the surrounding community. The 2016 FYR was described and the process briefed during the April 2015, October 2015, and March 2016 RAB meetings. The findings of this FYR will be discussed in a future RAB meeting.

At the end of the FYR, a newspaper notice will indicate that the FYR report is available for public viewing. The completed FYR report will be available at the site information repository, the Rockaway Township Public Library located on 61 Mount Hope Road in Rockaway, NJ and on the Picatinny Environmental Restoration website: [www.pica.army.mil/envRestore](http://www.pica.army.mil/envRestore).

#### **3.3 Site Inspection**

A site inspection was conducted as part of this FYR on December 1<sup>st</sup> and 2<sup>nd</sup>, 2015. Attendees of the site inspection included the following:

- Ted Gabel, Picatinny Arsenal Environmental Restoration Manager
- Erin Hauber, Engineer, CENWK
- Ken Kamp, Engineer, CENWK
- Greg Hattan, Geologist, CENWK

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The site inspection included a tour of the Picatinny Arsenal and an overview of the environmental program. The team also visited the Rockaway Township Public Library, which serves as the publicly available information repository for the Picatinny environmental restoration program. The visit found that the administrative record was readily accessible and well maintained. Many administrative documents and general information about the Picatinny environmental restoration program were also available at the following public website: <http://www.pica.army.mil/envRestore/>

Each of the 19 sites or groups of sites were briefly inspected to determine if the land use was consistent with the selected remedy and if there were any visually apparent issues that may affect the remedy's protectiveness. The FYR site inspection checklist form and photos documenting any observed concerns are included in **Appendix 3**. In general, no issues were noted during the inspection with the exception of a few monitoring wells were found without adequate locks (either no lock or unlocked). Annual land use control (LUC) inspection reports completed within this review period (i.e., 2011 through 2015) were reviewed for a more comprehensive understanding of whether LUCs were being maintained.

### **3.4 Site Interviews**

During the FYR process, interviews were conducted to document any perceived problems or successes with the remedies implemented to date.

During the site inspection, Ted Gabel, the Picatinny Installation Restoration Program (IRP) Manager, reviewed facility and site-specific background information with the FYR team and provided an overview of the sites considered within this FYR.

Surveys, consistent in content with FYR guidance, were distributed to thirteen members of Picatinny's 2015 RAB via email. Similar surveys were also distributed via email to regulatory managers from the USEPA and the NJDEP. Two RAB members responded either via phone or email in addition to the NJDEP. Community members felt well informed and that the cleanup progress has had a positive effect on the surrounding community.

One member recommended improving access to PICA-restoration information by expanding the existing public website, periodically scheduling a RAB meeting off-site, and assembling a site-wide tracking sheet geared towards community members who want to monitor cleanup progress through the CERCLA process. During follow-up with the Picatinny IRP Manager, Mr. Gabel noted that 1) the existing public website is regularly updated with new documents and site information, 2) the RAB meeting locations are determined through feedback from the RAB members and public notice meetings for Proposed Plans are held at offsite locations, and 3) an updated, site-wide tracking sheet with cleanup status is provided to RAB members during meetings and through meeting minutes.

No issues or concerns pertaining to protectiveness were identified by interviewees.

### **3.5 Document Review**

This FYR included a review of relevant information contained in a variety of site-related documents. The information review primarily focused on documents produced within the last FYR period or after December 2010, but in some cases included additional background documents. In general, common documents reviewed included:



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- ROD
- RD
- Annual Operation and Maintenance (O&M) or Monitoring reports
- Annual LUC inspection report
- Validated 2015 data and draft 2015 annual reports, when available

Due to the site-specific nature of most documents, sections dedicated to individual sites include a list of documents reviewed. However, the following is a list of documents and references common to all sites:

AECOM Joint Venture, 2015. Picatinny Arsenal Real Property Vision Plan. November.

ARCADIS, 2013. 2011 and 2012 Annual Land Use Certification. June.

ARCADIS, 2014. 2013 Annual Land Use Certification. June.

ARCADIS, 2014. 2014 Annual Land Use Certification and No Further Action Site Monitoring. December.

EA, 2016. Internal Draft 2015 Annual Land Use Certification and No Further Action Site Monitoring. January.

*Picatinny GIS Viewer (Restricted access)*. Picatinny Arsenal Environmental Department. Web. 2016. [http://giswebext.langan.com/picatinny\\_flex/webapp/picatinnyarsenal](http://giswebext.langan.com/picatinny_flex/webapp/picatinnyarsenal).

*Picatinny Environmental Restoration website (Public)*. Picatinny Environmental Restoration Program. Web. 2016. <http://www.pica.army.mil/envRestore/>.

United States Army, 2014. Final Biennial Certification Monitoring Report for Ground Water Classification Exemption Area. September.

United States Environmental Protection Agency (USEPA), 2011. Fourth Five-Year Review, Picatinny Arsenal. July.

USEPA, 2001. Comprehensive Five-Year Review Guidance, OSWER Directive 9355.7-03B-P. June.

## **4.0 Facility-Wide Background and Land Use Controls**

This section provides a brief overview of the site location and history, physical characteristics, land and resource use, history of contamination, initial response, and existing site-wide LUCs. Site specific information can be found in subsequent sections.

### **4.1 Site Location and History**

Picatinny Arsenal is a 5,900 acre government-operated munitions research and development facility located in Morris County, New Jersey, approximately 40 miles west of New York City and four miles northeast of Dover, New Jersey. The Arsenal sits in the Highlands of the State of New Jersey.

Picatinny Arsenal was established in 1880 by the U.S. War Department as a storage and powder depot. Later it was expanded to assemble powder charges for cannons and to fill projectiles with maximate (a propellant). During World War I (WWI), Picatinny Arsenal produced numerous sizes of projectiles. In the years following WWI, Picatinny Arsenal began projectile melt-loading operations and to manufacture pyrotechnic signals and flares on a production basis. During World War II (WWII), Picatinny Arsenal produced artillery ammunition, bombs, high explosives, pyrotechnics, and other ordnance. After WWII, Picatinny Arsenal's primary role became the research and engineering of new ordnance. However, during the Korean and Vietnam conflicts, Picatinny Arsenal resumed production and development of explosives, ammunition and mine systems.

In recent years, Picatinny Arsenal's mission has shifted to conducting and managing research development, life-cycle engineering, and support of other military weapons and weapon systems. The facility has responsibility for the research and development of armament items. The Base Realignment and Closure process in 2005 resulted in Picatinny being designated to remain open and to expand in mission.

### **4.2 Physical Characteristics**

#### **4.2.1 Topography**

The installation encompasses a wide central valley (Picatinny Valley) which is approximately seven miles long and a narrower parallel intermontane valley (Green Pond Gorge) about two miles long. Both are flanked by an easterly as well as a westerly ridge. The total breadth across the installation averages 1.5 miles. The valley is a glaciated river valley bounded by Green Pond Mountain to the northwest and Copperas Mountain to the southeast. Elevations at Picatinny range from near 685 feet (ft) to over 1,287 ft (elevations based on the National Geodetic Vertical Datum). Elevations are generally lower to the south and east of the installation and higher to the north and west. The maximum elevations at the Arsenal occur on the westerly ridge known as Green Pond Mountain with summits ranging from 800-1,287 ft. The southern region of Copperas Mountain (1,220 ft) extends into the northern portions of the Arsenal and separates the Denmark Lake Basin to the east from the higher elevated Green Pond Brook Basin to the west. The easterly portion of the Arsenal is composed of knobs with summits ranging from 860 ft to 1,066 ft. Local relief rises between 150 and 250 ft above Picatinny Valley. Frequent outcroppings of bedrock occur along the flanks. Green Pond Valley is filled with glacially-derived sediments surrounded and underlain by bedrock.

#### 4.2.2 Hydrology

The surface water flow regime at Picatinny consists of numerous streams, ponds, lakes, reservoirs, and wetlands. There are about 620 acres of lakes, ponds, and their associated scrub-shrub wetlands on the installation. The installation has two large lakes, Denmark Lake (174 acres) and Picatinny Lake (108 acres). Denmark Lake is located in the northeastern sector of the Arsenal. Historically, both of these lakes have been used as sources of industrial water, and as recreational areas.

The Arsenal comprises five main drainages:

- Green Pond Basin (Shrub Wetlands and Gorge; headwaters of Green Pond Brook [GPB])
- Denmark Lake Basin (Shrub Wetlands; headwaters of Burnt Meadow Brook)
- Middle GPB and Picatinny Lake
- Lower GPB
- Beaver Brook Sub-watershed, Ames Brook carries headwaters off of 250 acres of the eastern edge of the installation downstream into Beaver Brook

All lotic corridors comprise 24 miles on post. Water from GPB, as well as Denmark Lake, discharge southerly through the Picatinny Valley (7 miles), including Picatinny Lake near the center of the installation. All drainages at Picatinny empty into the Rockaway River south and east of the installation.

Picatinny contains approximately 1,250 acres of wetlands. These wetlands are primarily composed of muck and peat formed in poorly drained glacial soils. Excepting the open waters of lakes and ponds, the palustrine wetlands are nearly all red maple forests or scrub-shrublands. Wetlands distributed and scattered throughout the installation are very valuable to wildlife and serve as important groundwater recharge sites. The largest tract of red maple swamp is near the southern end of the installation.

Groundwater movement at Picatinny is in response to hydraulic gradients. In Morris County, the direction and magnitude of the natural gradients mimic the local topographic profile except that the water table profile has less relief. Groundwater is discharged directly to the streams wherever they intersect the water table and supports stream flow during periods of no precipitation. Groundwater flow in the valley is primarily horizontal and upward in both the unconfined and confined glacial aquifers and discharges into GPB. Picatinny's groundwater resides in the Upper Rockaway Aquifer and is a designated sole source aquifer.

#### 4.2.3 Geology and Hydrogeology

Picatinny lies within Green Pond Valley, a glaciated river valley bounded by Green Pond Mountain to the northwest and Copperas Mountain to the southeast. Green Pond Valley is filled with glacially-derived sediments surrounded and underlain by bedrock. The basement rocks are faulted by a series of northeast/southwest trending faults.

Four major aquifers have been identified beneath Picatinny although these four are specific to the Green Pond Valley:

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1. The unconfined aquifer which occurs within the valley floor and has a thickness of approximately 20 to 35 ft. This aquifer is continuous throughout the valley, with the exception of areas on the ridges where bedrock is exposed at the surface. Groundwater within this unit occurs from relatively near ground surface to about 30 ft below ground surface (bgs) in upland areas. Groundwater in the unconfined aquifer generally flows toward surface water discharge areas, such as GPB, Bear Swamp Brook (BSB), and Lake Picatinny. Groundwater flow velocities vary greatly in the unconfined unit based on varying permeability and gradient, and are estimated to range from 50 ft per year to over 300 ft per year.
2. The upper semi-confined aquifer generally encountered in the southern half of the valley.
3. The lower semi-confined aquifer which occurs beneath the upper only in the central valley portion of this area. As the unconsolidated sediments become thinner on the sides of the valley, this lower aquifer pinches out against the bedrock. Groundwater flow direction in the semi-confined aquifers is generally down valley to the southwest and towards surface water discharge areas. Vertical flow is typically upward towards discharge areas except where affected by groundwater withdrawal wells. Groundwater flow velocities are generally similar to the unconfined aquifer, though in some areas the lower semi- confined aquifer consists of coarser deposit with generally low hydraulic gradients.
4. The bedrock aquifer which exhibits faults, fold axes, bedding planes, and foliation trends that affect contaminant transport. Groundwater flow in the bedrock is generally towards the central valley and surface water features; however, locally the foliation and fracturing can alter and control flow directions along fractures and fault planes. Impacts to the bedrock aquifer, including trichloroethene (TCE) and explosives, have been documented in the Mid-Valley Groundwater (PICA-204); the 800 Building Area (PICA-079); Area K (PICA-50); and Area J (PICA-008) which is not part of this review.

The upper three valley-fill aquifers (unconfined, upper semi-confined, and lower semi- confined) have a maximum thickness of approximately 175 ft, and are impacted with various contaminants including chlorinated and hydrocarbon compounds, and explosives at the following PICA-sites: Area D Groundwater (PICA-076); Area B Groundwater (PICA-204); Area E Groundwater (PICA-077); 800 Area Buildings (PICA- 079); the Mid-Valley Groundwater (PICA-205); and the Optics Lab (PICA-013). GPB is the main surface water drainage pathway within the valley. Two man-made lakes (Lake Denmark and Picatinny Lake) are present, Picatinny Lake is drained by GPB and Lake Denmark is drained by Burnt Meadow Brook that flows into Picatinny Lake. Two tributaries to GPB, Robinson Run, and BSB flow from the ridges on the southeast and northwest sides of the valley, respectively. Wetlands and transition zones around the brooks are present throughout Picatinny Arsenal.

### **4.3 Land and Resource Use**

Picatinny Arsenal has the responsibility for research and development of armament items for the U.S. Army. Research and development operations are generally located on the valley floor and to a lesser extent on the valley walls and ridges.

Picatinny Arsenal is located within the Appalachian Oak Forest Region which at upper elevations is characterized by the birch-hemlock-maple-oak forest type. This cover type persists mainly in the

relatively undisturbed ridge crests, slopes, and moist ravines of Picatinny Arsenal. Bottomland areas prevalent in the valley floor consist of poorly-drained silty clays and peats which primarily support red-maple swamp forest. Much of the poorly-drained swamp area has been drained and filled to support base operations. Nevertheless, sufficient ecological habitat remains at Picatinny Arsenal to support a robust wildlife community.

As required by the regulations outlined in the Master Planning for Army Installations dated May 2005, Picatinny has developed a Real Property Vision Plan to guide the development, approval, and implementation of building projects at the Arsenal (AECOM 2015). This regulation provides for comprehensive planning at Army installations and not only allows, but requires, incorporation of existing land use and conditions into the Vision Plan. The Picatinny Office of the Chief Engineer in the Public Works Directorate is in charge of the Vision Plan. Picatinny's most recent approved plan is dated November 2015. Part IV of the Vision Plan includes restraints due to environmental impacts. There are no planned changes in land use at any of the sites included in this FYR.

While the predominant land use at Picatinny Arsenal is non-residential, there are a few areas with residential land use including military housing [Area D (PICA-076) and Mid-Valley Groundwater (PICA 204)], a child development center (Mid-Valley Groundwater), and various areas used for recreation. These areas are presented on **Figure 4-3** in addition to the extent of land use controls or land use monitoring for the 19 sites included in this FYR.

#### **4.4 History of Contamination**

Picatinny Arsenal is owned and operated by the U.S. Army and was a major source of munitions for WWI, WWII, the Korean War, and the Vietnam Conflict. During those periods, Picatinny Arsenal was involved in the production of explosives, rocket and munitions propellants, pyrotechnic signals and flares, and metal components. In recent years, Picatinny Arsenal's mission has shifted to conducting and managing research development, life-cycle engineering, and support of other military weapons and weapon systems. The facility has responsibility for the research and development of armament items.

Over the years, environmental investigations into the operations and waste management production activities at Picatinny Arsenal have indicated the potential for contamination at a number of sites. Between 1976 and 1981, United States Army Toxic and Hazardous Materials Agency (USATHAMA) conducted studies into possible contamination by chemical, biological, and radiological material at the facility. Based on this study, USATHAMA concluded that large sections of Picatinny Arsenal were contaminated by manufacturing wastes and unexploded ordnance (UXO). In 1987, NJDEP completed a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) for Picatinny Arsenal. The RFA identified 55 solid waste management units, many of which had been previously identified in the USATHAMA study. Subsequently, the Army conducted a Site Investigation (SI) in 1989 to assess the presence and potential for contaminant migration in groundwater.

Picatinny Arsenal was added to the National Priority List (NPL) in March 1990. A Federal Facility Agreement (FFA) was signed by the USEPA Region II and the U.S. Army in July 1991 to integrate the U.S. Army's CERCLA response and RCRA corrective action obligations into a comprehensive agreement. A Remedial Investigation/Feasibility Study (RI/FS) Concept Plan was prepared by Argonne National Laboratory in 1991 which identified 156 potentially-contaminated sites at Picatinny Arsenal. This concept plan was developed based on data gathered during previous investigations and a review of production records at Picatinny Arsenal.

The investigative approach suggested by the RI Concept Plan, initiated by the Army and approved by the regulatory agencies in 1990, was to break the defined RI Concept Plan sites into Areas (Area A-P). These 16 RI Concept-defined areas were prioritized and divided into three phases of investigation called Phase I, II, and III. The investigation of the Lower Burning Ground [RI-Concept Site 34 (PICA-002) of Area A], however, was initiated before the approval and normalization of this approach.

This original approach was modified by the implementation of the Department of Defense's Relative Risk Funding Policy. The goal of the relative risk policy is to attempt to address the worst sites first from a national or Department of Defense perspective. According to the guidance, the investigative and remedial actions for sites with the highest relative-risk were funded first with few exceptions.

Picatinny Arsenal RI Concept Sites were consolidated into PICA-sites as a result of the agreements made at a series of meetings that occurred in 2003 with the USEPA, the NJDEP, and the USAEC program managers. The consolidation was based on geographic attributes, similar schedules, and similar remedies. PICA-nomenclature is provided in parentheses in this FYR.

#### **4.5 Picatinny Institutional Controls, Facility-Wide Land Use Controls, and Groundwater Use Restriction**

##### **4.5.1 Picatinny Arsenal Controls and Safeguards**

Picatinny Arsenal has safeguards and institutional controls (ICs) in place to ensure protection of the environment and the health and safety of arsenal personnel and the public. While some of these controls serve as LUCs for sites within Picatinny's Environmental Restoration Program, these safeguards serve multiple purposes and are independent of the LUCs required by a site's ROD and RD under CERCLA. These controls include a soil clearance policy, Munitions and Explosives of Concern (MEC) policies, vision plan regulations, base access restrictions through Picatinny's Base Access Regulations, and an Army Safety Program.

The Picatinny Environmental Management System (PEMS) and its corresponding database are used to ensure environmental compliance during construction and other projects. Base access regulations and an Army Safety Program provide additional controls.

The PICA Soil Management Policy stipulates requirements for soil covering, soil movement, and soil management activities associated with construction activities at PICA. The project manager of the construction project, or a representative for the project, certifies a statement documenting understanding of and compliance with the soil management standard operating procedure. The signed certifications are then entered into PEMS. The Site Construction Manager's Statement requires that the point-of-contact for the project who is signing the statement agrees to the Site Construction/Project Implementation Requirements within the scope of work detailed within the PEMS database as input by the proponent.

As discussed in **Section 4.3**, Picatinny has developed a Real Property Vision Plan to guide the development, approval, and implementation of building projects at the Arsenal (AECOM 2015). This regulation provides for comprehensive planning at Army installations and requires incorporation of existing land use and conditions into the Vision Plan. Picatinny's most recent approved plan is dated November 2015. Part IV of the Vision Plan includes restraints due to environmental impacts. There are no planned changes in land use at any of the 19 sites included in this FYR.

#### 4.5.2 Land Use Controls

Picatinny Arsenal has LUCs in place to ensure protection of human health and the environment at sites where unlimited use and unrestricted exposure could result in unacceptable risks to human health and the environment. In this report, the term LUC is used to describe ICs and land use restrictions required by site RODs. Other controls and safeguards implemented as components of Picatinny's regular facility operations are discussed in the previous section; however in some instances, these Picatinny controls help fulfill site-specific LUC objectives.

Picatinny maintains a Geographic Information System (GIS) that contains LUC-related layers associated with areas described in each site's ROD. These LUC layers were included in a custom interface, EPRISM, which linked LUC information to Picatinny's GIS, accessible via the internet. The EPRISM interface and database was developed under a previous contractor (ARCADIS) and contained information on contaminated areas and associated land use restrictions. The database's continuation or replacement by a program similar in function is in development with the Environmental Chemical Corporation (ECC), who currently manages the GIS database. Picatinny's GIS website, the subsequent version EPRISM, and the national Army Mapper databases are tools used to ensure that LUCs are properly implemented and maintained.

The Annual Land Use Certification and No Further Action (NFA) Land Use Monitoring reports include the 19 sites or groups of sites with signed RODs and discussed within this FYR. The annual LUC and Land Use Monitoring reports ensure LUC objectives established within the site's LUC design document (i.e., remedial design [RD]) are being met. These reports include site-specific inspection forms, photo logs, and certifications. LUC reports from 2011 through 2015 were reviewed as part of this FYR.

#### 4.5.3 Groundwater Use Restriction

The State of New Jersey has designated most of the groundwater within the state as a drinking water source. However, a Classification Exception Area (CEA) was established for all groundwater beneath Picatinny Arsenal in both the bedrock and unconfined aquifers. The NJDEP approved the original CEA on 18 November 2002. Biennial certification for the CEA has since been conducted in 2008, 2010, 2012, and 2014. The most recent biennial certification (2014) was reviewed for as part of this FYR. Review of the 2016 Draft CEA is anticipated to be completed in 2016.

Upon establishment of a CEA, NJDEP identifies the region within the CEA as a well restriction area. The well restriction area functions as the IC by which potable use restrictions can be effected. As long as the CEA is in place, NJDEP may prohibit the installation and pumping of wells within this area.

While groundwater is extracted from potable water supply wells installed within the Mid-Valley to support PICA residents and operations, the groundwater is treated on-site prior to distribution. This use is consistent with its current Class IIA designation, which allows for treatment to render the water potable. Monitoring of potable water supply wells has been incorporated into the LUC component of the Mid-Valley and the Area D Groundwater remedies.

#### 4.5.4 Picatinny Potable Water Supply and Treatment

American Water maintains and owns Picatinny's potable water supply and distribution network to serve its entire population. American Water currently uses two drinking water supply wells, 302D (in Area G)

and 131 (in Area D). One other supply well, 430A, exists on PICA (in Area F) and but is currently not in use. Former supply well 410 has been decommissioned. TCE is present within the raw water pumped from these wells, and well head treatment is ongoing. To remove TCE and other potential contaminants prior to distribution, American Water treats all of its potable water via oxidation with potassium permanganate, air stripping, pH adjustment, and chlorination. This treatment process results in safe drinking water with contaminant concentrations below the maximum contaminant levels (MCLs) or no longer detected in the water. American Water currently uses this groundwater in a manner consistent with the definition of its Class IIA groundwater designation; i.e., the use of groundwater is not impacted by the contaminant plumes because conventional water supply treatment renders the water potable.

Groundwater extracted from potable supply wells is monitored for contamination as part the site-specific LUCs associated with sites where the potable extraction wells are located, including the Mid-Valley Groundwater (PICA-204) and Area D Groundwater (PICA-076).

#### **4.6 Basis for Taking Action**

At several sites contained in this FYR, the human health risk assessment (HHRA) determined the carcinogenic risk to human health posed by site specific contaminants of concern (COCs) fell within the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  or lower and the non-carcinogenic hazard was less than or equal to the Hazard Index (HI) criterion of 1 for the current and reasonably anticipated future land use. Receptors typically included the current outdoor maintenance workers, future industry/research workers, and future construction/excavation workers. Generally, a response action (RA) is implemented, following NCP guidance, when site-specific carcinogenic risk to human health exceeds  $1 \times 10^{-4}$ . Pursuant to an agreement with NJDEP, the Army agreed to evaluate and select remedial actions on a case by case basis at Picatinny Arsenal which are protective to the  $1 \times 10^{-6}$  level.



## 5.0 Site 23 (PICA-065) – Post Farm Landfill

### 5.1 Background: Site 23

The Site 23 (PICA-065) - Post Farm Landfill is approximately 10.3 acres and located near the southern corner of Picatinny Arsenal along the top of a ridge that forms the eastern boundary of the arsenal (**Figure 5-1**). The site consists of a Drum Burial Area (DBA) located in the southern portion of the site, a Northern Burial Area (NBA), and a Central Borrow Pit which is a cleared flat area located in the middle of the site. Both the DBA and the NBA are landfilled areas and are currently surrounded by perimeter fencing. The Central Borrow Pit is open and contains a mound of brush, debris, and fill soils.

Prior to 1940, the site was a farm. From the 1940s to the 1970s, the DBA received industrial wastes that included wastes generated at Picatinny. These drummed wastes included caustic paint stripper, used hydraulic oils, wastewater from oil reservoirs, tank cleaning wastes, fly ash, and solid waste. By 1951, any remaining farm buildings at the site had been demolished. In the 1950s, the site was mostly used for borrow pit material. Drums of paint remover were reportedly disposed of in trenches within the DBA. In the 1960s, a pit in the southern portion of the site received fly ash from coal burning operations, paint stripping wastes, phenols, and explosive-laden hydraulic oils either in containers or as free liquid. This pit was then covered with soil obtained from the Central Borrow Pit area. The site has recently used for disposal of clean fill and vegetative matter. The area around the site is currently used for recreational activities, primarily hunting. Several residences and warehouse buildings are located approximately 1,000 feet south of the site outside of the Picatinny boundary.

#### 5.1.1 Site Chronology: Site 23

**Table 5-1: Chronology of Site Events at Site 23**

Event	Date
Site Investigations	1981-1998
Feasibility Study	2001
Record of Decision	2004
Quarterly groundwater sampling	2003-2007
Third Five-Year Review (first for Site 23)	2006
Two-Year post remedy statistical assessment of groundwater data	2007
Five-Year post remedy statistical assessment of groundwater data	2010
Fourth Five-Year Review report	2011
Annual groundwater sampling	2008-2015

#### 5.1.2 Initial Response

A 1990 U.S. Geological Survey (USGS) geophysical survey identified numerous partially buried and potentially buried drums at the site. In response to a Notice of Violation for violations of the New Jersey Spill Compensation and Control Act and the Water Pollution Act related to the discovery of contaminants at the DBA, Picatinny Arsenal secured the site with fencing and initiated a contract to perform a drum removal and site investigation. In 1991, a contractor removed a total of 171 drums (predominantly 55-gallon), plus several smaller containers, from both the DBA and the NBA during the

drum removal and site investigation activities. Waste recovered from the NBA during the interim removal action was very similar to that identified in the DBA.

### 5.1.3 Basis for Taking Action

A remedial action was required to address MCL exceedances in groundwater in order to restore the groundwater to its beneficial use as drinking water aquifer as required by the Applicable or Relevant and Appropriate Requirements (ARARs).

In culmination of the findings from numerous studies and investigations, the following chemicals were identified in the ROD as COCs in groundwater: aluminum, cadmium, iron, lead, radium, silver, *cis*-1,2-dichloroethene (*cis*-DCE), 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), gross alpha, and gross beta. No COCs were identified for surface and subsurface soils, sediment, or surface water at the site.

During the HHRA, the carcinogenic risk and non-carcinogenic hazard was evaluated for the following three populations: current outdoor maintenance workers, future industry/research workers, and future construction/excavation workers. For exposure to surface and subsurface soils, carcinogenic risk fell within the NCP target range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  and the non-carcinogenic hazard was equal to the HI criterion of 1 for future industry/research workers and less than 1 for current outdoor maintenance workers and future construction/excavation workers.

Because volatile COCs were identified within groundwater, vapor intrusion potential was considered at the Post Farm Landfill. Post Farm Landfill does not contain structures; therefore there was no potential for indoor vapor intrusion. As of this FYR, the only remaining COC in groundwater with detections above SCLs at this site is cadmium.

## 5.2 Remedial Actions: Site 23

### 5.2.1 Remedy Selection

The ROD for the Post Farm Landfill was signed on December 20, 2004. The selected remedy was intended to prevent human contact with contaminants detected in groundwater and fly ash buried at the site. Remedial actions began in 2005 with the collection of the first long-term monitoring (LTM) samples and completed by 2007 when LUCs were fully implemented.

The selected remedy included the following components:

- LTM using the existing groundwater wells
- LTM of surface water and sediment from the off-post spring and seep
- Implementation of LUCs
- Collection of one round of surface soil samples from locations that previously exhibited exceedances of the LOCs to ensure isolated areas of contamination are not more widespread. If unexpected levels of contamination are found in the surface soil samples, additional topsoil may be placed at the site

The RAOs, as developed in the ROD, are as follows:

- Prevent human exposure to groundwater contaminated with COCs at levels greater than the chemical-specific ARARs through protection of points of compliance
- Prevent human exposure to and spread of fly ash and contaminated soil
- Protect uncontaminated on-post groundwater for future use
- Protect off-post groundwater, surface water, sediment, and soils for unlimited use
- Prevent human exposure to surface soils contaminated with COCs at levels greater than the chemical-specific levels of concern (LOCs)

### 5.2.2 Remedy Implementation

Based on the selected site remedy from the 2004 ROD, a RD was finalized in 2006. A groundwater LTM program was identified as a component of the site remedy in the 2004 ROD. The overall objective of the LTM program is to ensure that the selected remedy continues to be protective of human health and the environment. In particular, the objectives are to demonstrate that:

- the mitigation measure continues to protect uncontaminated on-post groundwater for future use
- the mitigation measure continues to protect off-post groundwater for unlimited use
- contaminants are not migrating to potential off-site receptors
- the contamination plumes are stable or decreasing over time

Quarterly LTM groundwater monitoring began in 2007 and consisted of sampling 11 existing groundwater wells. Monitoring wells locations are presented on **Figure 5-2**. With approval from the EPA and the NJDEP, the sampling frequency was reduced to annual in 2008. Annual groundwater sampling has continued from 2008 through 2015. Also, twenty-four surface soils samples were collected in 2007. Each sample was located 25 feet from previous locations to provide further delineation of potential impacted soils. All contaminants were documented below LOCs, therefore, in accordance with the ROD, placement of additional topsoil was not necessary.

**Section 4.5.2** discusses LUCs utilized at Picatinny and **Section 4.5.3** discusses the facility-wide CEA restrictions which are applicable at this site. As a component of the LUC remedy, several engineering controls were implemented at the site following the RD. Signage was installed around the Post Farm Landfill indicating the presence of an environmental soil cover and prohibition on digging. The DBA and NBA at the site were enclosed within a fence to restrict access following the interim removal action in 1991. **Figure 5-1** shows the locations of the signage and fencing at the Post Farm Landfill.

### 5.2.3 Operation and Maintenance

Quarterly LTM data reports were prepared and submitted in 2007 and 2008 following remedy implementation. In accordance with the RD, a Mann-Kendall statistical evaluation was completed and the sampling frequency was subsequently reduced to annual. Statistical evaluations were performed in 2010 and 2015, as required by the RD. As a result of these statistical analyses, the sampling parameters

and network have been reduced as COCs have been consistently documented below ARARs with no increasing trends identified in the Mann-Kendall evaluation. Statistical evaluations are performed in five-year increments to determine if removal of an analyte from a well or removal of a well from the annual LTM sampling is warranted, as allowed under the RD. The next evaluation will be performed in 2020.

As a result of the 2015 evaluation, the LTM program was reduced to include annual sampling at:

- DM23-03 for cadmium and field parameters
- Recommendation to discontinue all sampling at MW-23B, given three consecutive annual events with results below site cleanup levels (SCLs).
- Seep and spring locations (one of each) for *cis*-DCE

In 2013, monitoring well MW23-1B replaced MW-14 in the LTM program due to MW-14 being dry since 2008. MW23-1B was chosen as the replacement for MW-14 as it is the nearest hydraulically downgradient well from MW-14.

Implementation of LUCs at the site was the other component of the selected site remedy. LUC inspections have occurred annually at the site to verify the condition of the soil cover, condition of signage and fencing, and evaluation of the land use. Maintenance is performed, as needed, to repair items identified during the LUC inspection. An Annual LUC Certification report documents the findings of the LUC inspections for the site and is provided to the EPA and the NJDEP for review.

### **5.3 Progress Since Last Five-Year Review: Site 23**

The protectiveness statement from the fourth FYR stated:

*The remedy for the Site 23 (PICA-65) is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

Annual LUC inspections and LTM groundwater sampling have been performed at the Post Farm Landfill since the last FYR in 2011. No additional actions have occurred at the Post Farm Landfill since the previous FYR.

No issues or recommendations were identified in the previous FYR report.

### **5.4 Document and Data Review: Site 23**

#### **5.4.1 Document Review**

Relevant and appropriate documents associated with the Site 23 (PICA-065) - Post Farm Landfill remedy selection, implementation, LTM and sampling results were reviewed for this fifth FYR report. Site documents can be located at the PICA-website and the administrative record available at the Rockaway Township Public Library. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2009. Remedial Action Report Site 23 (PICA-065) - Post Farm Landfill. June.

Shaw Environmental Inc., 2004. Record of Decision, Site 23 (PICA-065) – The Post Farm Landfill. August.

Shaw Environmental Inc., 2006. Long Term Monitoring Plan and Land Use Control Remedial Design for Site 23 (PICA-065) – The Post Farm Landfill, Picatinny Arsenal, New Jersey. December.

#### 5.4.2 Data Review and Evaluation

Two monitoring wells and two surface water sample locations are included in the current LTM program. The surface water samples are collected from a nearby spring and a seep associated with the site.

#### **2015 LTM Sampling Event**

A final 2015 Annual Monitoring Report was not available at the time of this FYR report, however a draft version of the report and the data were available for preliminary review.

Two monitoring wells were sampled in 2015; however the surface water samples were not collected as no surface water or seep water was observed. A review of historical analytical data for the seep and spring locations shows samples have only been collected during the first and fourth quarters of 2003, and the second quarter of 2006.

Monitoring well DM23-03 was sampled for cadmium, and MW23-1B was sampled for TAL metals and radiologicals. The surface water, when present, is sampled for *cis*-DCE. Cadmium was detected at DM23-03 at a concentration of 6.0 micrograms per liter (µg/L) which is above the SCL of 4 µg/L.

Concentrations of cadmium in C-DM-23-03 were greater than SCLs and remain stable as no statistical trend was observed using the 2015 Mann-Kendall test. Concentrations of cadmium have not been greater than the trigger value (18.7 µg/L for cadmium), which if exceeded and increasing trends were observed, may lead to additional action beyond annual sampling.

There were no exceedances for TAL metals or radiological analytes at monitoring well MW23-1B.

The 2011 through 2014 LTM sampling events were conducted as specified in the RD and LTM flow chart included in the annual reports.

### **5.5 Technical Assessment: Site 23**

#### 5.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

##### 5.5.1.1 Remedial Action Performance

As a result of the interim removal action, a persistent source of contamination no longer exists at the Post Farm Landfill. The LTM groundwater monitoring program has shown that concentrations at the

site have remained below SCLs, with the exception of cadmium at one monitoring well; the concentrations of cadmium have remained steady since 2008. Due to the low levels of contamination remaining at the site, nearly all COCs have been removed from the sampling program as a result of the statistical evaluations performed in 2007 and 2010 and recommendations from the Draft Internal 2015 evaluation. The LUCs restrict access to the site, mitigate exposure pathways, and prevent the groundwater from being used as drinking water. Facility-wide groundwater use restrictions administered through the CEA are summarized in **Section 4.5**.

#### 5.5.1.2 Operations and Maintenance

The LUCs are properly maintained with repairs occurring as issues are identified, primarily replacing damaged signage. At minimum, deficiencies are noted during the annual LUC inspections and documented in the Annual Land Use Certification reports. No deficiencies or surface disturbances of the soil cover have been noted in the 2011-2015 reports at the site. Minor damage to the fence from fallen trees were noted in the 2011 and 2012 reports; however repairs had occurred by the 2013 inspection.

#### 5.5.1.3 Opportunities for Optimization

Optimization efforts have continually occurred through use of the LTM flow chart and trend evaluations occurring every five years, in accordance with the RD and exit strategy for the site.

#### 5.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified during this FYR.

#### 5.5.1.5 Implementation of Land Use Controls and Other Measures

The annual LUC inspections have successfully documented the condition of the site LUCs and verified no changes in land use have occurred.

### 5.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA Regional Screening Levels (RSLs) for tapwater and New Jersey Groundwater Quality Standard (NJGWQS). Based on the comparison of SCLs in the ROD to RSLs and NJGWQS, current groundwater concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP Ecological Screening Criteria (ESC) to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

The RAOs remain valid as they prevent exposure to human and ecological receptors of contaminated soils and protects nearby uncontaminated media from migration of site contaminants. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment.

#### 5.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No.

##### 5.5.3.1 Ecological Risks

No new information concerning ecological risks has been found that could call the protectiveness of the remedy into question. The removal and coverage of contaminated soil protects ecological receptors from surface exposures while surface water is monitored.

##### 5.5.3.2 Natural Disasters

No natural disasters have occurred that could call the protectiveness of the remedy into question.

##### 5.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information has come to light that could call into question the protectiveness of the remedy.

#### 5.5.4 Summary of Technical Assessment

Annual groundwater sampling under the LTM program has been performed, in accordance with the ROD and RD. The LTM groundwater monitoring program and statistical analyses have shown that COC concentrations at the site have remained below SCLs, with the exception of cadmium at monitoring well DM23-03. The LUCs at Site 23 are inspected annually and remain protective of human health and the environment. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. The RAOs ensure the groundwater is not used for drinking water and the land use remains industrial and thereby restricts potential exposure to contaminated soils. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

#### 5.6 Issues: Site 23

No issues which effect the protectiveness of the remedy were identified for Site 23 during this FYR.

#### 5.7 Recommendations and Follow-up Actions: Site 23

No recommendations or follow-up actions were identified for Site 23 during this FYR.

#### 5.8 Protectiveness Statement: Site 23

The remedy at Site 23 (PICA-065) – Post Farm Landfill is protective of human health and the environment.

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The following elements of the remedy have ensured that RAOs are being met. Annual groundwater sampling under the LTM program has been performed, in accordance with the ROD and RD. The LTM groundwater monitoring program and statistical analyses have shown that COC concentrations at the site have remained below SCLs, with the exception of cadmium at monitoring well DM23-03. The facility-wide CEA restricts access to and use of groundwater at Picatinny. LUC inspections have occurred annually to ensure the integrity of the vegetative cap, fencing, and signage is being maintained and to verify land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.



## 6.0 Site 20/24 (PICA-066) - Former Pyrotechnic Range and Landfill

### 6.1 Background: Site 20/24

The Site 20/24 (PICA-066) - Former Pyrotechnic Testing Range and Sanitary Landfill, is located in Area B near the southern boundary of Picatinny Arsenal (**Figure 6-1**). In 1940, the site was an undeveloped wetland area. Historical aerial photographs indicate the slow expansion of the site from two small clearings to the current site of approximately 28 acres. Approximately seven acres of the site have been used for miscellaneous waste and debris disposal that began in the 1960's and continued until 1972. The site also has been used for pyrotechnic testing. These activities led to contaminated soil and groundwater at the site. The Former Pyrotechnic Range and Landfill ROD addresses only contaminated soil. Contaminated groundwater at this site is addressed in the Area B Groundwater (PICA-205) ROD discussed in **Section 14** of this report.

#### 6.1.1 Site Chronology: Site 20/24

**Table 6-1: Chronology of Site Events at Site 20/24**

Event	Date
Proposed Plan	2001
Record of Decision	2001
Third Five-year Review (first for Site 20/24)	2006
Soil Cap Constructed	2002
Additional Soil Cap Constructed	2003
Site Closure Report	2005
Fourth Five-year Review (second for Site 20/24)	2011
Annual Inspections and Land Use Monitoring	2006-2015

#### 6.1.2 Basis for Taking Action

Previous investigations at this site have determined the COCs in surface and subsurface soils. The COCs in soil, as identified in the ROD, include:

- polychlorinated biphenyls (PCBs)
- lead
- 4,4'-dichlorodiphenyltrichloroethane (4,4'-DDT)

The risk to human health posed by these COCs fell within the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  and the HI is below 1 for the current and reasonably anticipated future land use. These receptors included the current outdoor maintenance workers, future industry/research workers, and future construction/excavation workers. The EPA disagreed with the HI calculation being less than 1. The Army calculated HI based on individual Aroclors whereas the EPA calculated HI for total PCBs which would result in a HI of 2.2. As discussed in **Section 4.6**, the Army chose to actively remediate the site based on the  $1 \times 10^{-6}$  risk level due to a specific request by the USEPA and the NJDEP to consider more active

remediation at this site. Additionally, potential for contaminants to be transported to surface water bodies during rain events was present.

A baseline ecological risk assessment (BERA) was performed as part of the 2000 FS to provide an estimate of ecological risks associated with contaminants found at the Former Pyrotechnic Range and Landfill. The ecological assessments for the site indicated no impacts to the plant community, toxicity to earthworms, or impact to small mammal populations. Risk modeling indicated a potential risk to the veery (a small bird) and woodcock from 4-4'-DDT and lead in soil and to a minor extent from exposure to aluminum and PCBs.

## **6.2 Remedial Actions: Site 20/24**

### **6.2.1 Remedy Selection**

The ROD for the Former Pyrotechnic Range and Landfill was signed on June 4, 2002. The RAOs developed in the ROD are specific to contaminated surface soils, subsurface soils, surface water, and sediment originating from the site. The RAOs for this site are as follows:

- Prevent exposure to contaminated media by human and biological receptors
- Protect uncontaminated media for future use
- Minimize migration of contaminants to adjacent media
- Protect environmental receptors

The selected remedy included the following components:

- Containment of soils with PCBs, lead, and 4,4'-DDT using a vegetated soil cover
- Excavation of soils that lie outside of the area to be capped and contain contaminants above remedial goals (RGs) and placement of those soils within the area proposed for capping
- Enforcement of access restrictions designed to prevent disturbances of the soils cover to prevent any non-industrial use of the site

**Section 4.5.2** discusses LUCs utilized at Picatinny which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants. A site map depicting the LUCs established at the site is included as **Figure 6-1**.

### **6.2.2 Remedy Implementation**

Remedial activities began in 2002 and continued through 2004. One-hundred and forty-seven (147) cubic yards (CY) of soil containing PCBs which exceeded 300 milligrams per kilogram (mg/kg) were removed and transported for off-site disposal at a commercial hazardous waste landfill permitted to accept PCB contaminated wastes. An additional 1,005 CY of soil containing PCBs less than 300 mg/kg were relocated from areas beyond the planned perimeter of the cap and consolidated beneath the vegetative cover. During remedial activities, unexploded ordnance were discovered at the site which

required removal prior to completing the remedial action. The unexploded ordnance was successfully removed from the site and disposed. A two foot cover of clean soil was placed to cap approximately 2.4 acres of soil contaminated with PCBs, lead, and 4,4'-DDT. Site restoration was completed to develop wetlands, and LUCs were implemented to restrict site access and soil cover disturbance. Much of the wetlands within the Former Pyrotechnic Range and Landfill were mitigated as part of the Former Lower Burning Grounds remediation (**Section 19**) and referred to as mitigation area No. 1.

#### 6.2.3 Operation and Maintenance

Quarterly site inspections were initiated in December 2003 and continued through 2006. In 2006, the site inspection frequency was decreased to annually in compliance with the LUC Implementation Plan (LUCIP) completed in November 2001. The presence of LUCs and condition of the soil cover also are verified in the inspection and subsequently certified in Annual Land Use Certification Reports. Annual Certifications have been prepared for 2011 through 2014, and will continue until LUCs are no longer required.

O&M required for the soil cover is minimal, but will be perpetual. Maintenance to the cap will be limited to the repair of any damage noted in the inspections and annual mowing of the cap area.

### 6.3 Progress Since Last Five-Year Review: Site 20/24

The protectiveness statement from the fourth FYR stated:

*The remedy for Site 20/24 (PICA-66) is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

No recommendations or issues were identified in the fourth FYR.

Inspections and LUC Certifications have been performed annually from 2011 to 2014. **Section 14** of this report documents the progress since the last FYR for the groundwater contamination at the site.

### 6.4 Document and Data Review: Site 20/24

#### 6.4.1 Document Review

Relevant and appropriate documents associated with Site 20/24 (PICA-066) were reviewed for this fifth FYR Report. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

IT Corporation (IT). 2002. Remedial Action Work Plan for the Construction of a Soil Cap at Site 20/24 Pyrotechnic Testing Range (Final). Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083. July.

Picatinny Arsenal. 2001. Site 20/24 Record of Decision (Final). November.

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Shaw Environmental, Inc. (Shaw), 2003. Addendum to the Remedial Action Work Plan for the Construction of a Soil Cap at Site 20/24 Pyrotechnic Testing Range (Final). Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95- D-0083. June.

Shaw Environmental, Inc. (Shaw), 2005. Site 20/24 – Site Closure Report (Draft Final). Prepared for U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D- 0083. October.

#### 6.4.2 Data Review and Evaluation

No new data have been collected since the fourth FYR. Analytical data are not collected as part of the annual site inspections.

### 6.5 Technical Assessment: Site 20/24

#### 6.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

##### 6.5.1.1 Remedial Action Performance

Land use remains consistent with the assumptions made at the time of the decision documents. The soil cover continues to function as intended by the decision documents by minimizing human and biological receptors' exposure to contaminated media and through minimizing migration of contaminants. The remedy remains protective of human health and the environment.

##### 6.5.1.2 Operations and Maintenance

Since 2011 the soil cover has not required any repairs; only annual mowing has been performed.

##### 6.5.1.3 Opportunities for Optimization

No opportunities for optimization were identified during this Five-Year Review.

##### 6.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified during this FYR.

##### 6.5.1.5 Implementation of Land Use Controls and Other Measures

The LUCs at the site prevent unintentional exposure to contaminated media. The annual LUC inspections have successfully documented the condition of the site LUCs and verified the integrity of the cap and that no changes in land use have occurred.

6.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for industrial soil and New Jersey Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC). Based on the comparison of SCLs in the ROD to RSLs and New Jersey NRDCSCC, current soil concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

The RAOs remain valid as they prevent exposure to human and ecological receptors of contaminated soils and protects nearby uncontaminated media from migration of site contaminants. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment.

6.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

6.5.3.1 Ecological Risks

No new information concerning ecological risks has been developed that could call into question the protectiveness of the remedy.

6.5.3.2 Natural Disasters

No natural disasters have occurred during the review period that could call the protectiveness of the remedy into question.

6.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information was discovered during the review period that could call the protectiveness of the remedy into question.

6.5.4 Summary of Technical Assessment

The land use at the Pyrotechnics Range and Sanitary Landfill remains consistent with the assumptions made in the ROD, and the soil cover continues to prevent exposure to soil contaminants. LUC inspections have occurred annually with maintenance of the soil cover being performed as needed. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. The groundwater contamination is being addressed under the Area B ROD which is discussed in detail in **Section 14** of this FYR report. Exposure assumptions made in the ROD remain

valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

#### **6.6 Issues: Site 20/24**

No issues which effect the protectiveness of the remedy at the Pyrotechnics Range and Sanitary Landfill (PICA-066, Site 24) have been identified during this fifth FYR.

#### **6.7 Recommendations and Follow-up Actions: Site 20/24**

No recommendations or follow-up actions have been identified for the Pyrotechnics Range and Sanitary Landfill (PICA-066, Site 24) during this fifth FYR.

#### **6.8 Protectiveness Statement: Site 20/24**

The remedy at the Pyrotechnics Range and Sanitary Landfill (PICA-066, Site 24) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Soils with COCs above SCLs have been excavated and either disposed off-site or consolidated beneath the vegetative cap. The vegetative cap has prevented receptor exposure. Annual LUC inspections have ensured the integrity of the vegetative cap, fencing, and signage is being maintained and has verified that land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 7.0 Site 25/26 (PICA-067) - Former Landfill and Dredge Pile

### 7.1 Background: Site 25/26

The Site 25/26 (PICA-067) - Former Landfill and Dredge Pile is located within the central valley of Picatinny Arsenal near the southern boundary (**Figure 7-1**). The northeastern section of the site is next to a parking lot used for the softball fields. A large and dense thicket covers the section of the site next to the parking lot. Behind the thicket are shrubs and overgrown grasses. At its closest point (the northwest corner), the site is approximately 50 ft east of GPB. The eight-acre site consists of level grasslands, mounds, and low-lying wet areas.

An abandoned railroad track forms the northern boundary of the site. The eastern and southern boundaries of the site consist of Site 163 (PICA-092) - Baseball Fields and the western boundary is largely formed by South Brook Road. The Dredge Pile portion of the site (Site 26) consisted of an irregularly shaped pile of sediments (approximately 12,000 CY of sediments) dredged from portions of GPB and located approximately in the center of the Former Landfill.

A wide variety of wastes were reportedly disposed of at the Former Landfill from the 1940s through the early 1970s. The wastes may have included rubbish, industrial wastes, shells, and sewage treatment plant sludge. The Former Landfill received a soil and vegetated cover after discontinued use by the Army in 1972.

The Dredge Pile (Site 26) is a fully-vegetated and irregularly shaped pile of sediments (approximately 12,000 CY) dredged from portions of GPB and placed at the Former Landfill in 1982. GPB had received waste from most operations at Picatinny Arsenal, including sewage and industrial wastewater discharges, storm runoff, and discharge from contaminated groundwater plumes.

The soil at the Former Landfill became contaminated with organic compounds and metals due to the landfill activities. The groundwater beneath the site is being evaluated and addressed separately within the Area C Groundwater (PICA-206) found in **Section 16** of this report.

#### 7.1.1 Site Chronology: Site 25/26

**Table 7-1: Chronology of Site Events at Site 25/26**

Event	Date
Interim Corrective Measures Soil Investigation	1984
USGS Geophysical Survey	1986
Site Investigation	1988
Soil Investigation	1991
Phase I Remedial Investigation	1993-1994
Additional Soil Investigation for PAHs	1997
Feasibility Study	2003
Record of Decision	2007
Response Action completed	2007
Annual LUC Inspections	2007-2015

Event	Date
Final Remedial Action Report	2009
Fourth Five-Year Review (First for Site 25/26)	2011

#### 7.1.2 Basis for Taking Action

Several historical investigations were conducted at the Former Landfill and Dredge Pile Site (PICA-067, Site 25) to determine the nature and extent of site impacts to surface and subsurface soil. Several polycyclic aromatic hydrocarbons (PAHs) and copper were detected at a concentration that exceeded their respective screening levels for surface soil. The COCs identified in surface soil are as follows:

- copper
- lead
- *benz(a)anthracene*
- *benzo(a)pyrene*
- *benzo(b)fluoranthene*
- chrysene
- benzo(k)fluoranthene
- *dibenz(a,h)anthracene*
- indeno(1,2,3-cd)pyrene
- total PCBs
- 4,4'-DDT
- pentachlorodibenzo-p-dioxin (1,2,3,7,8-PeCDD)
- 2,3,7,8-TCDD

The only class of constituents that exceeded SCLs for subsurface soil were PAHs, as identified in italics above. This examination concluded that contaminants in subsurface soil do not adversely affect groundwater beneath the site. The risk to human health posed by these COCs fell within the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  and the HI is below 1 for the current and reasonably anticipated future land use. These receptors included the current outdoor maintenance workers, future industry/research workers, and future construction/excavation workers. As discussed in **Section 4.6**, the Army chose to actively remediate the site based on the  $1 \times 10^{-6}$  risk level due to a specific request by the USEPA and the NJDEP to consider more active remediation at this site.

An Ecological Risk Assessment (ERA) and Risk Management Plan concluded the ecological hazards are acceptable for all contaminants, except for selenium and 4,4'-DDT. Selenium concentrations were determined to be within background levels and thus eliminated as a contaminant of potential ecological concern. The ROD determined a RA for 4,4'-DDT was not warranted because the state cleanup level is higher than the maximum detected concentration of 4,4'-DDT, the site is too small to support enough species of concern, and the ecological receptors do not spend a sufficient amount of time contacting the affected media.

SCLs were established for COCs which contributed (through dermal exposure) to unacceptable risk to human health and the environment at the site. The SCLs were developed using NJDEP criteria. Only three of the COCs had SCLs less than their maximum detected concentrations: *benzo(a)anthracene*, *benzo(a)pyrene*, and *benzo(b)fluoranthene*.



## 7.2 Remedial Actions: Site 25/26

### 7.2.1 Remedy Selection

The ROD for the Former Landfill and Dredge Pile was signed on July 3, 2007. The RAO developed in the ROD is specific to the contaminated soils originating from the site. The RAO for the site is to prevent exposure to contaminated soils impacted by COCs above SCLs.

The selected remedy for the Former Landfill and Dredge Pile included installation of a small vegetated soil cover and implementation of LUCs.

### 7.2.2 Remedy Implementation

The RA was completed in 2007 and included construction of a vegetated soil cover over 12,700 square feet (sf) of the site. The vegetated soil cover consisted of a 12-inch compacted common fill layer overlain by a six-inch topsoil layer. The vegetated soil layer is above the existing grade, and the soil cover transitions with a 3:1 slope to match the existing grade. Approximately two CY of soil were excavated from soil sample location 25/26GR-3. The excavated soil was consolidated and covered by the vegetated soil cover.

**Section 4.5.2** discusses LUCs utilized at Picatinny which are applicable at this site. LUCs were implemented for the entire site to ensure the integrity of the vegetative cover and maintain protectiveness of human health. A site map with the LUC area of applicability is included as **Figure 7-1**.

### 7.2.3 Operation and Maintenance

Annual site inspections were initiated in December 2007 and continue to be completed on an annual basis. The presence of LUCs and condition of the soil cover are also verified in the inspection and subsequently certified in Annual Land Use Certification Reports. O&M required for the soil cover is minimal, but will be perpetual.

## 7.3 Progress Since Last Five-Year Review: Former Landfill and Dredge Pile

The fourth FYR was the first FYR to occur once the ROD was signed for the site. The protectiveness statement from the fourth FYR was:

*The remedy for Site 25/26 (PICA-67) is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

No issues or recommendations were made in the previous FYR.

## **7.4 Document and Data Review: Site 25/26**

### **7.4.1 Document Review**

Relevant and appropriate documents associated with the site were reviewed for this fifth FYR Report. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2007. Final Remedial Action Work Plan, Site 25/26 (PICA-067) – Sanitary Landfill and Dredge Pile. July.

ARCADIS, 2009. Final Remedial Action Report, Site 25/26 (PICA-067) – Sanitary Landfill and Dredge Pile. Picatinny Arsenal, New Jersey. June.

### **7.4.2 Data Review and Evaluation**

No new data have been collected since the fourth FYR. Analytical data are not collected as part of the annual site inspections.

## **7.5 Technical Assessment: Site 25/26**

### **7.5.1 Question A**

*Is the remedy functioning as intended by the decision documents?*

Yes.

#### **7.5.1.1 Remedial Action Performance**

The soil cover continues to function as intended and prevents the potential exposure of human and environmental receptors to COCs.

#### **7.5.1.2 Operations and Maintenance**

Annual inspections have occurred at the site with no major maintenance requirements identified.

#### **7.5.1.3 Opportunities for Optimization**

No opportunities for optimization were identified during this FYR.

#### **7.5.1.4 Early Indicators of Potential Issues**

No early indicators of potential issues were identified during this FYR.

#### **7.5.1.5 Implementation of Land Use Controls and Other Measures**

The annual LUC inspections have successfully documented the condition of the site LUCs and verified no changes in land use have occurred.

7.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for industrial soil and New Jersey NRDCSCC. Based on the comparison of SCLs in the ROD to RSLs, current soil concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

The RAOs remain valid as they prevent exposure to contaminants. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment.

7.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

7.5.3.1 Ecological Risks

No new information concerning ecological risks was found that could call into question the protectiveness of the remedy.

7.5.3.2 Natural Disasters

No disasters have occurred during the review period that could call into question the protectiveness of the remedy.

7.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information was discovered during the review period that could call the protectiveness of the remedy into question.

7.5.4 Summary of Technical Assessment

The land use at the Former Landfill and Dredge Pile remains consistent with the assumptions made in the ROD, and the soil cover continues to prevent exposure to soil contaminants. LUC inspections have occurred annually with maintenance of the soil cover being performed as needed. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. The groundwater contamination is being addressed under the Area C ROD which is discussed in detail in **Section 16** of this FYR report. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

**7.6 Issues: Site 25/26**

No issues which effect the protectiveness of the remedy at the Former Landfill and Dredge Pile (PICA-067, Site 25) have been identified during this fifth FYR.

**7.7 Recommendations and Follow-up Actions: Site 25/26**

No recommendations or follow-up actions have been identified for the Former Landfill and Dredge Pile (PICA-067, Site 25) during this fifth FYR.

**7.8 Protectiveness Statement: Site 25/26**

The remedy at the Former Landfill and Dredge Pile (PICA-067, Site 25) is protective of human health and the environment.

The following elements of the remedy have ensured that the RAO (to prevent exposure to contaminated soils impacted by COCs above SCLs) is being met. Installation of a vegetative soil cover and implementation of LUCs has prevented receptor exposure. Annual LUC inspections have ensured the integrity of the soil cover and signage is being maintained and has verified that land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active.

## 8.0 Area D (PICA-076) Groundwater

### 8.1 Background: Area D Groundwater

Area D (PICA-076) Groundwater occupies approximately 90 acres in the south-central section of the Arsenal and encompasses 14 study sites (**Figure 8-1**). As detailed in the Record of Decision (ROD) (U.S. Army, 2004), the most prominent feature of Area D is a chlorinated solvent plume in groundwater. Building 24 was a plating facility in operation from 1930 to 1981 and is considered the source of Area D (PICA-076) Groundwater contamination. Washing and degreasing of metal parts prior to plating generated waste TCE which reportedly flowed to a dry well located adjacent to Building 24 via an overflow line. It is posited that this dry well was the primary release mechanism of TCE to groundwater. In addition, two infiltration lagoons were associated with Building 24 operations. Treated waste water from Building 24 was diverted to these lagoons. The lagoons and dry well were removed and closed under RCRA in 1991.

Between 1981 and 1985, 21 wells were installed in the vicinity of Building 24. These wells were sampled periodically between 1981 and 1985 by various agencies and analyzed for volatile organic compounds (VOCs), phenol, metals, anions, and cyanide. Results of this sampling indicated that TCE migrated to groundwater forming a plume which discharges to Green Pond Brook (GPB) 1,600 ft away. Approximately 1,100 ft at its widest point, the plume is primarily located in the unconfined aquifer.

Numerous industrial activities are conducted in this area of the Arsenal, including vehicle maintenance, waste accumulation and storage, surveillance laboratory operation, and photographic processing. This area also contains administrative space, the post cafeteria and several military housing units, as well as a portion of the base golf course. No VOC contamination originated from these latter activities.

Groundwater supply well 131 is located within the boundaries of Area D east of Building 34. It is screened in the lower semi-confined and bedrock aquifers, and is located below the majority of the contaminated groundwater. The water produced by well 131 contains low levels of TCE. This water is extracted and treated to remove VOC compounds prior to consumption, as detailed in **Section 4.5.4**.

The future land use of Area D is anticipated to remain unchanged from current land use. Area D will continue to be used for industrial activities by the Army. All of the water generated from supply wells at Picatinny is monitored regularly.

#### 8.1.1 Site Chronology

**Table 8-1: Chronology of Site Events at Area D Groundwater**

Event	Date
Interim Action ROD	1989
RCRA Closure of Dry Well and Lagoons	1991
Interim Action Hydraulic pump and treat barrier implemented	1992
First Five Year Review	1996
Area D Groundwater Feasibility Study Data Gap Investigation Work Plan	1997
Soil Gas Infiltration Study Buildings within the RI Concept Area D	1997
Phase I Remedial Investigation	1998

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Event	Date
Second Five Year Review	2001
Area D Groundwater FS	2003
Proposed Plan for Area D Groundwater	2003
Record of Decision	2004
Area D Groundwater Permeable Treatment Wall Pre-Design Characterization Study Data Report	2004
Area D HRC Groundwater Pilot Study Report	2005
2007 Annual Monitoring Report	2007
2008 Annual Monitoring Report	2008
Final RD Area D Groundwater	2008
Interim Remedial Action Report Area D	2008
Construction Completion Report Area D Groundwater	2008
2009 Annual Monitoring Report	2009
Area D Groundwater Sampling Reductions for 2010	2010
2010 Annual Monitoring Report	2010
Fourth Five-Year Review	2011
2011-2014 Annual Monitoring Report	2012-2015

#### 8.1.2 Initial Response

In September of 1992, an interim action hydraulic barrier pump and treat system was implemented to intercept contaminated groundwater prior to discharge to GPB. The hydraulic barrier pump and treat system was installed between the plume centroid and GPB. This pump and treat system was operated from 1992 until 2007, after implementation of the selected remedy.

#### 8.1.3 Basis for Taking Action

In culmination of the findings of numerous studies, the following chemicals have been identified as COCs:

- 1,1-dichloroethene (1,1-DCE)
- *cis*-DCE
- tetrachloroethene (PCE)
- TCE
- vinyl chloride (VC)

However, it should be noted that the majority of the Area D Groundwater plume contains only TCE. The remaining COCs listed above are found at lower levels.

The 1998 Phase I RI included an HHRA for Area D groundwater, surface water, and air. Hypothetical future exposure of groundwater to workers, adult/child residents, and child residents were evaluated for ingestion, inhalation, and skin contact risks. Groundwater contact through any of these pathways is not expected to occur because of the facility-wide CEA and LUCs that are in place (**Section 4.5**). The evaluation of the potential risk from contaminated surface water considered the risk to trespasser swimmers. The results of the HHRA indicated that under the current and hypothetical exposure scenarios at Area D (PICA-76) Groundwater, the COCs pose an unacceptable risk to human health and exceed applicable drinking water standards. A remedial action was required to address this unacceptable risk to human health and restore the groundwater to its beneficial use as a drinking water aquifer.

## **8.2 Remedial Actions: Area D Groundwater**

### **8.2.1 Remedy Selection**

The Interim Action ROD for Area D Groundwater was signed on September 28, 1990. The selected interim remedy for Area D Groundwater consisted of a pump and treat remedy to intercept contaminated groundwater prior to discharge into GPB. The interim remedy was implemented in 1992 and included the following components:

- Extraction of contaminated groundwater
- Pretreatment system for the removal of metals and solids
- Air stripping for removal of VOCs
- Discharge of treated water to GPB

The Final ROD for Area D Groundwater was signed on September 22, 2004. As part of the Final ROD for Area D Groundwater the following RAOs were developed:

- Prevent exposure to contaminated groundwater
- Establish ICs to restrict access to the contaminant plume
- Protect uncontaminated ground and surface water for designated uses
- Minimize migration of contaminants to adjacent ground and surface water
- Restore contaminated ground and surface water to comply with their respective use designations
- Comply with ground and surface water ARARs
- Continue to ensure the protection of environmental receptors

The final remedy was implemented in 2007 and included the construction of a permeable reactive barrier (PRB) with monitored natural attenuation (MNA), discontinuation and decommissioning of the pump and treat system and implementation of ICs.

### 8.2.2 Remedy Implementation

In April 2007, the PRB was installed using continuous trenching technology which consisted of simultaneous excavation of soil and backfilling with an iron-sand mixture. The PRB includes two distinct sections. The first 80 ft length has a depth of 35 ft and a 55% target iron percentage (by mass); the second section is 220 ft long with a depth of 28 ft and a target iron percentage of 45% (by mass). The as-built width of the PRB varies between 1.1 ft and 1.2 ft, less than the design width of 1.5 ft; however the iron loading was increased above the target (approximately 57% to 100%) to compensate for shallower PRB width. This PRB was designed to treat groundwater before discharging to GPB; therefore it is considered the final action required to address surface water.

Also in 2007, the MNA program, which is the final remedial action for groundwater, was initiated. The projected duration of the MNA remedy is 170 years.

Upon collecting three years of data to monitor MNA at the site, the PRB performance, and surface water conditions, the USEPA concurred with removing the pump and treat system that was idle from 2007 through 2010. The pump and treat system was decontaminated and decommissioned in August 2010.

Because volatile COCs were identified within groundwater at Area D, vapor intrusion potential was considered. Indoor air sampling was conducted at buildings overlying the plume in 2007 and 2008, including buildings 11, 30, 33, 34, 61, 62, 92, 100, 102, 112, 113, 117 and 127 (ARCADIS, 2008a, 2008b). Of the detected constituents, one result for TCE collected from Building 30 exceeded the NJDEP non-residential Indoor Air Screening Levels (IASL). Based on the exceedance of the IASL for TCE at Building 30 in 2007/2008, a site-specific risk assessment was conducted. The risk calculations indicated the total cancer risk for TCE was equal to  $3 \times 10^{-6}$  and noncancer hazards for TCE equal to 0.11 (Arcadis, 2008b). Buildings 25 and 31 were not sampled; however, as of this current FYR, Building 25 is near a non-detect well (D-13-1). Buildings 25 and 31 are both commercial/industrial, are similar in use and structure, with similar or lower VOCs in underlying groundwater compared to surrounding buildings that were sampled. Therefore, it is anticipated that potential exposure via vapor intrusion would be similar to that of surrounding buildings.

**Section 4.5.2** discusses LUCs utilized at Picatinny and **Section 4.5.3** discusses the facility-wide CEA restrictions which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants.

### 8.2.3 Operation and Maintenance

The PRB is designed to function without the need for maintenance and will remain in place through the end of the remedial action. Per the 2008 RD, the PRB was designed to eliminate the need for zero-valent iron (ZVI) change out. The O&M requirements associated with the PRB include compliance and performance monitoring. The wells comprising the PRB performance monitoring network and MNA network are inspected periodically and maintained throughout the remedial action.

## 8.3 Progress Since Last Five-Year Review: Area D Groundwater

The protectiveness statement from the fourth FYR was:



*The remedy for Area D (PICA-076) Groundwater is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

There were no issues or recommendations in the fourth FYR. Subsequent to the last FYR, PRB performance monitoring and surface water compliance sampling has been conducted as well as annual MNA monitoring of groundwater wells. Annual inspections and LUC certification have been completed.

## **8.4 Document and Data Review: Area D Groundwater**

### **8.4.1 Document Review**

Relevant and appropriate documents associated with Area D (PICA-076) Groundwater investigations, remedy development, and operations were reviewed for this fifth FYR report. Key documents reviewed included:

ARCADIS, 2008a. 3Q07 and 4Q07 Quarterly Groundwater Report. April.

ARCADIS, 2008b. Results of Indoor Air Sampling at Building 30. May.

ARCADIS, 2008c. Final Remedial Design, Area D Groundwater. July.

ARCADIS, 2008d. Interim Remedial Action Report Area D Groundwater. August.

ARCADIS, 2008e. Draft Final Construction Completion Report Area D Groundwater (PICA-076). August.

ARCADIS, 2008f. Interim Remedial Action Report. August.

ARCADIS, 2010. Area D Groundwater Sampling Reductions for 2010. January.

ARCADIS, 2012a. 2011 Annual Monitoring Report, Area D (PICA-076) Groundwater. August.

ARCADIS, 2012b. 2012 Annual Monitoring Report, Area D (PICA-076) Groundwater. October.

ARCADIS, 2014a. 2013 Annual Monitoring Report, Area D (PICA-076) Groundwater. May.

ARCADIS, 2014b. 2014 Annual Monitoring Report, Area D (PICA-076) Groundwater. November.

EA Engineering, Science, and Technology, Inc., 2016. Internal Draft 2015 Annual Monitoring Report, Area D (PICA-076) Groundwater. February.

Shaw, 2004. Area D Groundwater Permeable Treatment Wall Pre-Design Characterization Study Data Report. August.

Shaw, 2005. Area D HRC Groundwater Pilot Study Report. July.

U.S. Army, 2003. Proposed Plan for Area D Groundwater. July.

U.S. Army, 2004. Picatinny Arsenal Area D Groundwater Record of Decision.

#### 8.4.2 Data Review and Evaluation

The following trends in data were identified as part of this FYR and documented in the Annual Reports (2013 - 2014). Statistical analysis is conducted and is included as an Appendix in the Annual Reports. The following summary is based upon data from the final 2013 and 2014 monitoring reports and the Internal Draft 2015 monitoring report. Sampling locations included in this discussion are shown on **Figure 8-2a** and **8-2b**. To facilitate review, trend charts from the Draft Internal 2015 annual report are included as **Table 8-2**. The PRB component of the remedy was implemented for the protection of surface water. For this reason, compliance sampling, defined as monitoring to verify that the PRB is achieving the RAOs and surface water performance objectives, is based on surface water sampling in Green Pond Brook. Therefore, the wall is designed to reduce CVOC mass such that surface water results are below SCLs.

##### 8.4.2.1 PRB Performance

Performance groundwater monitoring data from annual reports through 2014 indicate that the PRB is performing as designed and protecting Green Pond Brook. A discussion of PRB performance is organized into a review of COC trends, geochemical results, and water levels directly from wells installed directly upgradient, within, at either end of the wall, and directly downgradient of the PRB. While most monitoring locations include a deep and a shallow well, as shown on **Figure 8-2a**, the majority of the mass is located within the shallow interval and is the focus of this data review.

**Trends directly upgradient of the PRB:** Maximum TCE concentrations immediately upgradient of the PRB in performance well D-PRB-1 have been decreasing over the last five years from approximately 4,620 µg/L in 2011 to 116 µg/L in 2014. At well D-PRB-03, located directly upgradient of the PRB on the northwestern end, concentrations of TCE appear to have steadily declined since 2009. These concentrations are treated in the PRB, where the maximum detected TCE concentration detected in the three piezometers constructed within the PRB was 173 micrograms per liter (µg/L) in D-PZ-1 in 2014.

**Trends within and on ends of PRB:** In 2015, sample results from D-PRB-9, located on the southwestern end of the PRB (beyond the outer extent), detected TCE at 63.4 µg/L, compared to the historical maximum of 1.98 µg/L in 2007. Results from D-PRB-10, located on the northeastern end of the PRB, were below detection limits during the reporting period. Three piezometers are constructed within the wall to monitor treatment, D-PZ-1, 2, and 3. Samples collected from piezometers installed within the southwestern portion of the PRB wall (D-PZ-1) showed an increase in TCE and *cis*-DCE from August 2013 to July 2014 (TCE: 32.6 µg/L to 173 µg/L; *cis*-DCE: 130 µg/L to 556 µg/L, respectively). Similarly, at D-PZ-2, located within the wall, near the wall's midpoint, concentrations of VC increased from a historical maximum of 2.18 µg/L in 2007 to 79.1 µg/L, in 2015. These detections indicate some TCE and an uptick in degradation products are breaking through to the mid-point of the PRB. Results from D-PZ-3 located within the northeastern portion of the wall, included detections of *cis*-DCE up to 21.8 µg/L but no clear trend or indications of an increase in concentrations.

**Trends directly downgradient PRB:** A recent, marginal increase in VC at D-PRB-7 (38.7 µg/L in 2015 versus 7.2 µg/L in 2013) may be reflective of the increase in TCE and *cis*-DCE observed at mid-wall piezometer, D-PZ-1. At shallow well D-PRB-05, observations of VC, beginning in 2012, likely reflect the fluctuations in *cis*-DCE at mid-wall piezometer, D-PZ-03. Trends from well D-41-9 demonstrate the PRB's effectiveness: TCE remains low relative to pre-wall levels (less than 11 µg/L from 2010-2015 versus historical maximum of 1,810 µg/L), *cis*-DCE has decreased from 485 µg/L in 2010 to 57.5 µg/L in 2015, and concentrations of VC have remained stable during the reporting period (132 µg/L to 175 µg/L from 2010 to 2015). In summary, results from wells installed between the PRB and GPB demonstrate the PRB has been effective in reducing mass before reaching GPB.

**Geochemical Parameters:** Groundwater geochemical data are collected to evaluate and track PRB performance relative to the wall design. Bench-scale treatability tests indicated that alkalinity was expected to decrease significantly across the PRB (Shaw, 2004) and summarized in Table 5 of the RD. Alkalinity data collected in the shallow wells upgradient, within and downgradient of the PRB from 2012 through 2015 decreased at least 50 milligrams per liter (mg/L), lower than the approximately 120 mg/L reduction observed in the treatability study. Sulfate also decreases across the wall, most notably at the piezometers constructed within the wall and along the southwestern influent/effluent pair, PRB-01 and PRB-07. Sulfate is likely decreasing due to microbially mediated reduction, which generally results in formation of iron sulfide minerals such as pyrite. Other geochemical parameters such as oxidation-reduction potential (ORP), chloride data, and dissolved iron display significant variability across wells and over time and do not appear to be reliable predictors of PRB performance. The design of the wall assumed carbonate precipitation may play a significant role in porosity reduction.

#### **Factors Affecting Wall Effectiveness:**

Wall permeability is a function of both porosity and hydraulic conductivity within the PRB. Decreases in either of the components will result in a change in retention time of the targeted contaminant within the wall (which affects dechlorination kinetics), or in a worst case scenario, will affect the capacity for groundwater to travel through the wall over time (ARCADIS, 2005). The wall's porosity was designed to be 1.5 times greater than the formation (30% vs. 20%) to accommodate a reduction in porosity due to mineral precipitation and production of hydrogen gas.

**Water Levels:** Water levels have been collected from the PRB monitoring network near the wall and site-wide wells significantly upgradient of the wall; however it is difficult to assess the direction of groundwater flow without additional data points between the wall and the closest upgradient point, D-112-6. In light of the recent detection of TCE at PRB-09, reduced treatment or breakthrough observed at piezometers constructed within the wall, and the 2014 detection of TCE at D-SW-4 above the SCL, collection of additional water levels from existing wells near the PRB: 41-12, W6-S/M, W2-S/M and 41-11 may help understand whether groundwater is flowing around the wall as a result of reduced permeability or if this is a result of natural plume migration shown in the modeling reports (Appendix A of the RD). The potential influence of potable water supply Well D-PW-131 on plume behavior should also be considered as part of this evaluation.

#### **8.4.2.2 PRB Compliance**

Surface water data from Green Pond Brook further indicate the protectiveness of the PRB. Historically, low concentrations of COCs periodically have been detected in surface water samples D-SW-2, D-SW-8, D-SW-3, and D-SW-4 prior to installation of the PRB in April 2007. After installation of the PRB, at

upstream location D-SW-2, all COCs displayed stable trends (based on a review of COC concentration plotted versus time). At downstream locations, sporadic detections of VC above the SCL have been observed in GPB in D-SW-3, D-SW-4, and D-SW-8. In 2014, TCE was detected in D-SW-4 above the SCL. The RD states that, “an exceedances of the 1.09 µg/L SCL for TCE) during a PRB compliance sampling event, while not anticipated, will trigger confirmatory sampling and a more frequent sampling schedule to confirm data and to determine whether the elevated detection is isolated, a result of a seasonal pattern, or consistent.” A confirmation sample, collected within the two weeks of the exceedances was below detection limits for all CVOCs.

For groundwater, the ROD requires implementation of a MNA remedy along with ICs. The duration for MNA to reach chemical-specific groundwater standards is anticipated to be greater than 30 years. Ultimately, MNA will be the final remedy in place after the PRB has outlived its performance period. MNA sampling is conducted in the following wells (**Figure 8-2a**):

- Former Source Area: D-9-H
- Plume Centerline: D-92-3, D-112-6, D-112-7, D-MW21-1, D-CAF-2, D-CAF-6
- Upgradient and Crossgradient Background: D-13-1, D-111-1
- Sentinel: D-41-8, D-41-9, D-41-16, D-41-17, D-41-14, D-41-1, D-MWD-1

#### 8.4.2.3 Former Source Area/Centerline Wells

Monitoring well D-9-H, at the Former Source Area, continues to exceed the TCE SCL with a gradual increase in concentration since the fourth Five Year Review. Plume centerline wells remain above the SCL with a maximum concentration of 2,900 µg/L observed at D-92-3 in 2014. Decreasing trends for *cis*-DCE and TCE were observed in D-111-1. D-CAF-2 also indicated a decreasing trend for TCE as reported in the 2014 annual report and the preliminary 2015 data. Increasing trends for *cis*-DCE were observed in D-CAF-6 and D-92-3. At D-112-6, TCE concentrations have increased compared to 2003 values and have varied in the range of several hundred µg/L since 2006; the most recent concentration being 225 µg/L in September 2015. The former source area and centerline wells are upgradient of the PRB.

There has been an increase in degradation products *cis*-DCE and VC within the plume indicating natural attenuation is occurring. The ARCADIS solute transport model suggests that TCE groundwater concentrations will still exist at high levels for the next 40 years (ARCADIS, 2008c).

#### 8.4.2.4 Sentinel Wells

Trends in sentinel wells are used to evaluate the stability of the Area D plume. TCE was detected at concentrations exceeding the SCL in three wells (D-41-9, D-41-16, and D-41-17). PCE has also been detected at low levels in Well D-41-16 at a maximum concentration of 1.1 µg/L in July 2014. The 2014 annual report provided a statistical analysis of TCE trends, and decreasing trends were observed in sentinel wells D-41-9 and D-41-16. No significant trend was noted in the other sentinel wells. Since 2007, no COCs were reported in sentinel monitoring wells D-MWD-1 (downgradient from the PRB) or D-41-1 (downgradient and across GPB).

#### 8.4.2.5 Potable Water Supply Well D-PW-131

Concentrations of TCE were reported above the cleanup standard of 1 µg/L in the potable water supply sample from D-PW-131 during the four monitoring events conducted since 2011. A review of the concentration versus time trend plots (included in the Annual Groundwater Data Reports) indicates the concentration has remained stable and ranged between 3.92 µg/L (July 2014) and 5.32 µg/L (September 2012). It is noted these samples are influent samples collected prior to treatment and distribution for potable purposes. Treatment of these wells is discussed in **Section 4.5.4**. During this review, it was noted that samples collected from the wellhead of D-PW-131 have not been historically analyzed for 1,4-dioxane. While there is no direct evidence that 1,4-dioxane is present in groundwater at Area D, the next two rounds of sampling at D-PW-131 should include analysis of 1,4-dioxane, given potential exposure concerns and specialized ex situ treatment needed to treat 1,4-dioxane.

### 8.5 Technical Assessment: Area D Groundwater

#### 8.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

Data presented in the annual reports document the PRB is performing as designed and natural attenuation is occurring.

##### 8.5.1.1 Remedial Action Performance

RCRA actions conducted in 1981 and the early 1990s removed most of the contaminant source in the soil. LUCs and engineering controls have remained in place and have been inspected and certified annually. The ROD stated the timeframe to achieve the SCLs for COCs at Area D is approximately 170 years. For groundwater, the ROD requires implementation of a MNA remedy along with ICs. MNA sampling is currently being conducted annually. The duration for MNA to reach chemical-specific groundwater standards is anticipated to be greater than 30 years. Ultimately, MNA will be the final remedy in place after the PRB has outlived its performance period.

##### 8.5.1.2 Operations and Maintenance

The PRB is designed to function without the need for maintenance and will remain in place through the end of the remedial action. Per the RD (ARCADIS, 2008c), the PRB was designed to eliminate the need for ZVI change out. The O&M requirements associated with the PRB include compliance and performance monitoring. The PRB component of the remedy was implemented for the protection of surface water. For this reason, compliance sampling, defined as monitoring to verify that the PRB is achieving the RAOs and surface water performance objectives, is based on surface water sampling in Green Pond Brook. In addition to the compliance sampling, additional performance monitoring is conducted to evaluate the performance of the PRB. The wells comprising the PRB performance monitoring network and MNA network are inspected periodically and maintained throughout the remedial action.

PRB performance and MNA monitoring are completed in accordance with the RD (and recommendations from final annual monitoring reports), and monitoring reports are generated annually to summarize the PRB performance.

#### 8.5.1.3 Opportunities for Optimization

As discussed in **Section 8.4.2.1**, a number of geochemical parameters display significant variability across the wells and do not appear to be reliable indicators of PRB performance. Additionally, collection of parameters such as methane, ethene, and ethane may be beneficial to demonstrate the level of biologically mediated reduction occurring near the PRB, as suggested by the presence of VC.

#### 8.5.1.4 Early Indicators of Potential Issues

The groundwater samples collected in 2015 at PRB-9, southwest of the PRB, detected TCE at 63.4 µg/L potentially indicating contamination by-passing the PRB. The 2014 sample from D-SW-4, located immediately downgradient of the PRB in GPB exceeded the SCL for TCE (although a confirmation sample collected two weeks later was below detection limits). In addition, samples collected within the southwestern portion of the PRB wall (D-PZ-1) showed an increase in TCE and *cis*-DCE from August 2013 to July 2014 (TCE: 32.6 µg/L to 173 µg/L; *cis*-DCE: 130 µg/L to 556 µg/L, respectively). Similarly, at D-PZ-2, located within the wall, near the wall's midpoint, concentrations of VC increased from a historical maximum of 2.18 µg/L in 2007 to 79.1 µg/L, in 2015. These detections indicate some TCE and an uptick in degradation products are breaking through to the mid-point of the PRB. While additional treatment is achieved through the second portion of the wall and attenuation between the wall and GBP, these increases in concentration should be closely monitored to understand their potential impact to GBP. It should also be noted that concentrations in wells between the PRB and GPB (D-PRB-7, D-PRB-5, D-41-9) have not significantly changed during the review period.

The TCE detections in D-SW-4 in GPB in 2013 and 2014 and in Well PRB-9 in 2015 could be attributed to natural plume migration (as depicted in Appendix A of the Final RD) or to changes in the groundwater flow direction in the vicinity of the PRB, potentially due to declines in PRB permeability over time. A comprehensive groundwater flow map should be provided in each annual report depicting groundwater flow patterns from all of Area D. Additional piezometers and/or monitoring wells (such as collecting water levels from existing wells near the PRB: 41-12, W6-S/M, W2-S/M and 41-11 [locations not currently monitored are not shown on figures]) may be necessary to provide a better understanding of the flow pattern. The potential influence that potable water supply Well D-PW-131 (with an average annual pumping rate of 250 to 365 gallons per minute) has on plume geometry and contaminant distribution should be included in this analysis. This flow pattern would provide an understanding of the flow direction both local the PRB and beyond the immediate vicinity of the PRB. Collection of additional groundwater samples from the existing monitoring wells listed above could also be performed in order to more carefully evaluate concentration trends upgradient of the PRB and changes in mass flux over time.

Increasing concentrations of PCE or TCE upgradient of the PRB or in the plume source area may indicate a need for evaluating changes to the PRB if intra-plume wells do not exhibit decreasing concentrations within the 30 year time frame predicted as part of the RD. At this time only monitoring well D-9-H, at the Former Source Area, indicated gradual increase in concentration since the fourth Five Year Review; the other intra-plume wells were decreasing or had no significant trend.

#### 8.5.1.5 Implementation of Land Use Controls and Other Measures

The facility-wide CEA restricts use of groundwater at the site and the LUCs and engineering controls prohibit changes in the land use from what was assumed in the ROD. The LUCs and engineering controls are in place and inspected and certified annually.

#### 8.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for tapwater and NJGWQS. Based on the comparison of SCLs in the ROD to RSLs and NJGWQS, current groundwater concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

The potential for VI was assessed by reviewing the results and conclusions of the 2007/2008 VI studies, comparing these results to current NJDEP IASLs, and using the USEPA Vapor Intrusion Screening Level (VISL) calculator to calculate indoor air risk using indoor air results from the previous VI studies. Risks were found to be below or within the USEPA acceptable range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ , and hazards were below 1. The previous assumptions for this risk assessment and current conditions were reviewed as part of the FYR and conclusions from previous VI studies remain valid.

The RAOs remain valid as they prevent exposure to groundwater contaminants by human and ecological receptors, and minimize migration of contamination. By eliminating unacceptable risks, the RAOs ensure the remedy remains protective of human health and the environment until the contaminated groundwater is restored to its designated use.

#### 8.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

#### 8.5.3.1 Ecological Risks

Detection of TCE in D-SW-4 in 2014 and D-PRB-9 in 2015 indicate that contamination in groundwater may be migrating southward toward surface water where it could impact ecological receptors. Increased frequency of sampling affected wells and the surface water may be warranted to ensure that the remedy remains protective for ecological receptors.

#### 8.5.3.2 Natural Disasters

No natural disasters have occurred that could call the protectiveness of the remedy into question.

#### 8.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information was discovered during the review period that could call the protectiveness of the remedy into question.

#### 8.5.4 Summary of Technical Assessment

The remedy has been implemented and is operating as intended by the ROD and RD. Groundwater and surface water monitoring have been conducted consistent with the RD to evaluate PRB effectiveness and protection of surface water as well as COC trends from within and near the extent of the Area D groundwater plume. While the PRB is functioning as designed and protecting GPB, monitoring results may indicate overall reduced effectiveness of the PRB or contaminant flow to the southwest of the PRB as a result of reduced wall permeability or natural plume migration. Annual LUC inspections, sampling of potable water supply well D-PW-131, and maintenance of the facility-wide CEA restricting groundwater use ensures LUCs remain effective at restricting potential exposure to contaminated groundwater and surface water. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### 8.6 Issues: Area D Groundwater

No issues have been identified that affect the current protectiveness; however an early indication of a potential issue discussed in **Section 8.5.1.4** may affect the future protectiveness of the Area D Groundwater remedy.

Issues	Affects Protectiveness (Y/N)	
	Current	Future
1. Based on TCE detections at surface water monitoring location D-SW-4 in GPB in 2014, in well D-PRB-9 (located on southwestern end of PRB) in 2015 and increased concentrations of TCE and DCE at D-PZ-1 and degradation products (D-PZ-2), observed within the PRB, the PRB may be losing treatment efficiency and/or the plume may be moving to the south of the PRB, due to natural causes or reduced PRB permeability.	N	Y



## 8.7 Recommendations and Follow-up Actions: Area D Groundwater

Recommendations / Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-up Actions: Affects Protectiveness (Y/N)	
				Current	Future
1. Recommend increasing the monitoring frequency of the PRB wells and the surface water from annually to semi-annually to monitor PRB performance. Conduct a thorough evaluation of PRB performance as a part of the next annual monitoring report.	U.S. Army	USEPA	2021	N	Y
2. Recommend defining areas with high concentrations of CVOCs upgradient of the PRB where focused <i>in-situ</i> bioremediation (ISB) can be conducted and to reduce MNA timeframe and ultimately mass flux to the PRB. ISB has been implemented at Picatinny at Area B Groundwater, Group 3 sites, and Mid-Valley. Findings, recommendations and a feasibility level cost estimate will be summarized in a technical memorandum.	U.S. Army	USEPA	2021	N	Y

Additional data collection (water levels, supplemental sampling for VOCs, and collection of biologically reductive dechlorination parameters methane, ethene, and ethane) discussed in **Section 8.5.1.3**, may support a better understanding of 1) groundwater flow in Area D and local to the PRB, 2) mass flux into the PRB, 3) overall PRB effectiveness and 4) design of an *in-situ* bioremediation (ISB) study. This ISB study requires an understanding of the areas with high concentrations of CVOCs upgradient of the PRB where focused ISB can be conducted and can meaningfully reduce the MNA timeframe and ultimately mass flux to the PRB. ISB has been implemented at Picatinny at Area B Groundwater, Group 3 sites, and Mid-Valley and a pilot study is likely unnecessary. These findings will be summarized and include a conceptual approach to implementing ISB, and a feasibility level cost estimate in the form of a technical memorandum. The decision to implement ISB will weigh the additional cost against reductions in remedial lifecycle costs and long-term risk.

#### 8.7.1 Other Recommendations

During the next two regularly scheduled sampling events, samples collected from the wellhead of potable water supply well D-PW-131 should be analyzed for 1,4-dioxane.

### 8.8 Protectiveness Statement: Area D Groundwater

The remedy at Area D (PICA-076) Groundwater currently protects human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Groundwater and surface water monitoring have been conducted consistent with the RD to evaluate PRB effectiveness and protection of surface water as well as COC trends from within and near the extent of the Area D groundwater plume. Annual LUC inspections, sampling of potable water supply well D-PW-131, wellhead treatment of D-PW-131 and operation in compliance with NJDEP drinking water permit, and maintenance of the facility-wide CEA restricting groundwater use ensures LUCs remain effective at restricting potential exposure to contaminated groundwater and surface water. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: increased monitoring of PRB wells and surface water and a thorough evaluation of PRB performance as a part of the next annual monitoring report as well as evaluating use of enhanced bioremediation upgradient of the PRB. To support this evaluation, supplemental data collection is recommended, as outlined in **Section 8** of this FYR.

## 9.0 Area E (PICA-077) Groundwater

### 9.1 Background: Area E Groundwater

Area E (PICA-077) Groundwater is approximately 38 acres in size and is located in the south-central portion of Picatinny Arsenal (**Figure 9-1**). Area E borders Third Avenue to the northwest, BSB to the northeast, and GPB to the southeast. Area E encompasses four study sites and includes the area with the ongoing groundwater remedy at Site 38 (Building 95, Printed Circuit Board Manufacturing Operations Treatment Facility), PICA-077.

Degreasing and cleaning with chlorinated solvents (part of metal plating operations for printed circuit board manufacturing) was conducted at Building 95. These activities produced contaminated wastewater containing VOCs and other chemicals. This wastewater was stored and treated in nine underground storage tanks (USTs) that were installed beneath Building 95 in 1961. This activity no longer takes place in Building 95 and currently is used for administrative office space.

Chlorinated solvents were introduced to the subsurface via leaking USTs, pipes, and sludge lagoons. These solvents were introduced into the groundwater via infiltration of waste water containing relatively low levels of TCE. This discharge of wastewater resulted in a groundwater plume with relatively low aqueous concentrations and limited amounts of solvents in the subsurface soil beneath the lagoons. Groundwater investigations indicate that Area E groundwater, primarily from within the unconfined shallow aquifer, was contaminated with chlorinated VOCs. Additionally, metals including arsenic, beryllium, iron and manganese have been detected in both the shallow unconfined and the semi-confined aquifers in Area E. However, these metal contaminants may be attributable to aquifer properties and underlying bedrock, rather than anthropogenic (man-made) sources. RCRA actions conducted in 1981 and the early 1990s removed most of the contaminant source in the soil. As a result, the contaminant mass transported to the groundwater was reduced, as supported by the results of the Data Gap Investigation (IT Corporation, 1999) that suggested that contamination in the subsurface soil is minimal in the areas immediately downgradient of the two suspected source areas and does not appear to be continuously impacting groundwater. Area E groundwater in the unconfined aquifer moves in a south-southeasterly direction to the area of Building 80, where ultimately it discharges to Green Pond Brook.

#### 9.1.1 Site Chronology: Area E Groundwater

**Table 9-1: Chronology of Site Events at Area E Groundwater**

Event	Date
Phase I Remedial Investigation	1998
Data Gap Investigation	1999
Area E Groundwater Feasibility Study	2002
Proposed Plan for Area E Groundwater	2004
Record of Decision	2007
Final Remedial Design Area E Groundwater & Site 22	2008
2007 Annual Land Use Certification	2008
Site 23 (PICA-065) – Post Farm Landfill; Area D (PICA-076) and Area E (PICA-077) Groundwater	2008

PICATINNY ARSENAL  
FIFTH FIVE-YEAR REVIEW REPORT

Event	Date
2008 Monitoring Report	2009
2008 Annual Land Use Certification	2009
2009 Monitoring Report	2010
2009 Annual Land Use Certification	2010
Biennial Certification for a Groundwater Classification Exemption Area	2010
Fourth Five-Year Review (first for Area E)	2011
2012-2015 Monitoring Report	2013-2016

#### 9.1.2 Basis for Taking Action

In culmination of the findings of numerous studies, the following chemicals were originally identified as COCs in groundwater:

- 1,1-DCE
- *cis*-DCE
- PCE
- TCE
- VC

The Phase I RI (Dames and Moore, 1998) included an HHRA for Area E (PICA-077) Groundwater. Hypothetical future exposure of groundwater to workers, adult/child residents, and child residents were evaluated for ingestion, inhalation, and skin contact risks. Groundwater contact through any of these pathways is not expected to occur because of the facility-wide CEA and LUCs that are in place. The results of the HHRA indicated that under the current and hypothetical exposure scenarios at Area E (PICA-077) Groundwater, the COCs pose an unacceptable risk to human health and exceed applicable drinking water standards. Per the Final ROD for Area E (PICA-077) Groundwater, the remedial action was undertaken to protect human health and the environment from contaminant concentrations in excess of groundwater standards. A remedial action was required to address the exceedances of groundwater standards and restore the groundwater to its beneficial use as a drinking water aquifer. The remedial action for Site 22 was undertaken based on subsurface soil concentrations of beryllium and copper that exceeded the NJDEP non-residential standards.

Because volatile COCs were identified within groundwater at Area E, vapor intrusion potential was considered within the ROD. As summarized in the ROD, detected groundwater detections were compared against VI screening criteria and results from the Area D VI studies, which reflect similar site conditions but with lower groundwater concentrations. The ROD concluded that no further evaluation of the VI pathway was required due to groundwater concentrations below screening criteria and indoor air results below the OSHA TWA at Area D Groundwater.

## 9.2 Remedial Actions: Area E Groundwater

### 9.2.1 Remedy Selection

The Final ROD for Area E (PICA-077) Groundwater was signed on September 28, 2007. The RAOs for Area E (PICA-077) Groundwater are specific to groundwater contamination identified within Area E. The RAOs for Area E Groundwater are:

- Prevent human consumption of, and contact with, contaminated Area E groundwater
- Prevent contamination of uncontaminated Area E groundwater and surface water with COCs
- Restore contaminated Area E groundwater to comply with its use designation. The designated use of groundwater underlying Area E is Class IIA groundwater, whose primary use is potable water and/or conversion to potable water through conventional treatment, mixing, or similar techniques.

As an additional safeguard, the RAO to prevent human consumption of Area E groundwater will be met by the Picatinny Arsenal CEA until attainment of the third RAO above, aquifer restoration, is met. The facility-wide CEA is discussed in **Section 4.5.3**. The risks identified in the previous section will be mitigated by attainment of these RAOs, as the only unacceptable human health risk is due to ingestion of the Area E groundwater. By preventing consumption of the groundwater, the human ingestion risk is mitigated.

The selected remedy for Area E Groundwater included MNA and LUCs. The selected remedy for Site 22 included implementation of LUCs. A site map is included as **Figure 9-1**.

### 9.2.2 Remedy Implementation

To implement the selected RA for groundwater the MNA sampling program began in September 2007. Groundwater samples were collected from the MNA network monitoring wells and surface water samples collected from Green Pond Brook. All samples were analyzed for VOCs, total and dissolved iron, nitrates and sulfates. Field parameters (temperature, pH, oxidation-reduction potential (ORP), specific conductance, dissolved oxygen, and turbidity) were recorded during sampling.

**Section 4.5.2** discusses LUCs utilized at Picatinny and **Section 4.5.3** discusses the facility-wide CEA restrictions which are applicable at this site. LUCs were implemented to restrict groundwater use and control exposure to beryllium and copper contaminated sub-surface soils. The first LUC site inspection was completed on December 5, 2007 with the most recent reviewed LUC site inspection completed in 2014 although an inspection occurred in 2015.

## 9.3 Progress Since Last Five-Year Review: Area E Groundwater

The protectiveness statement from the fourth FYR was:

*The remedy for Area E (PICA-077) Groundwater is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

No issues or recommendations were identified during the previous FYR.

Subsequent to the fifth FYR, MNA monitoring of groundwater wells and surface water/sediment sample locations has been conducted. MNA monitoring was conducted semi-annually in 2011 and 2012 and reduced to annually from 2013 through 2015. Additional monitoring wells were sampled in 2011, 2013 and 2015 as part of biennial sampling. Annual inspections and LUC certification has been completed.

#### **9.4 Document and Data Review: Area E Groundwater**

##### **9.4.1 Document Review**

Relevant and appropriate documents associated with Area E (PICA-077) Groundwater investigations, remedy development, and operations were reviewed for this fifth FYR report. Key documents reviewed included:

ARCADIS, 2008. Final Remedial Design, Area E Groundwater and Site. Prepared for U.S. Army Corp of Engineers. June.

ARCADIS, 2014a. 2013 Annual Monitoring Report. May.

ARCADIS, 2014b. 2013 Annual Land Use Certification. Picatinny Arsenal, New Jersey. June.

ARCADIS, 2014c. 2014 Annual Monitoring Report. October.

ARCADIS, 2014d. 2014 Annual Land Use Certification. Picatinny Arsenal, New Jersey. December.

EA Engineering, Science and Technology, 2016. Internal Draft 2015 Annual Monitoring Report Area E (PICA-77). January.

IT Corporation (IT), 2002. Final Area E Groundwater Feasibility Study. Prepared for the U.S. Army Corps of Engineers, Baltimore District. Contract No. DACA-31-95-D-0083

USEPA, 2007. Final Record of Decision, Area E Groundwater and Site 22 (Building 95 Impoundment Area). July

##### **9.4.2 Data Review and Evaluation**

As of 2015, sampling is conducted annually at ten monitoring wells and three surface water sampling locations. Seven additional monitoring wells are sampled biennially. Sampling locations are presented on **Figure 9-2**. MNA concentrations versus time trend plots are included as an appendix with every annual groundwater report. To facilitate review, trend charts from the Draft Internal 2015 annual report are included as **Table 9-2**. Specific data review and evaluation is below:

**Plume Center/Fringe Monitoring Wells:** In the seven plume center/fringe monitoring wells, concentrations of one or more COCs remain above the SCL. A slight increasing trend was observed for Well E70-4 for 1,1-DCE, *cis*-DCE and VC, although since the implementation of the monitoring plan, no TCE or PCE has been detected in these wells. Concentrations have remained stable at Well E-WG3-2 and E-MW-01 for the five COCs. Concentrations of PCE have been declining at Well E-12-L while TCE and *cis*-DCE have been relatively stable. Concentrations have fluctuated periodically at E-W11-1

and E-12-H. A new maximum concentration of PCE was observed in well E-95-3 (94.6 µg/L) in July 2014; to a lesser extent, other COCs (1,1-DCE, *cis*-DCE, and TCE) were also detected at new maximum concentrations at this well. Well E-95-3 typically has the highest concentrations of PCE; however, a significant decrease in the concentration of PCE (4.1 µg/L) was observed in September 2015. Similar fluctuations in PCE concentrations have historically been observed at E-95-3 and may be explained by the shallow water table and the fact that well E-95-3 is closest to the historical source of contamination near Building 95.

**Downgradient Monitoring Wells:** In the three in-plume monitoring wells (E82-1, E-MW-02, and E-80-3) downgradient of the plume center, concentrations of COCs are generally stable.

**Surface Water Sampling:** Concentrations of constituents in surface water samples (D-SW-5, E-38-SW-001, and E-38-SW-004) collected from GPB are generally non-detect or below the SCL for all constituents with the exception of VC. Low levels of VC (less than 1 µg/L) have historically been detected above the SCL (0.082 µg/L) at all three sampling locations, including the D-SW-5, located generally upstream of where the plume intersects with GPB. Similar concentrations of VC have also been observed at surface water monitoring locations associated with Area D, located approximately 1,500 feet from the Area D Groundwater PRB (**Section 8.0**). The results of the 2015 sampling event were below the detection limit.

**Progress Towards RAOs:** Groundwater concentrations of the five COCs remaining in the monitoring wells eight years after implementation of the ROD remain in exceedance of SCLs at several locations in the plume. There is no evidence that the plume is expanding. Groundwater data from monitoring well E-95-3 has exhibited high variability in PCE concentrations ranging from a high of 94.6 µg/L in July 2014 to 4.1 µg/L in September 2015. The variability in groundwater data particularly observed at E-95-3 suggests that further annual monitoring data are needed to estimate the remedial timeframe.

**Analysis of 1,4-dioxane at Targeted Wells:** During this review it was noted that 1,1,1-trichloroethane (1,1,1-TCA) has been detected in historical groundwater samples collected from Area E. Due to 1,4-dioxane's widespread use as a stabilizer for 1,1,1-TCA, the two contaminants are commonly present together. A review of available data indicates Area E groundwater has not been analyzed for the presence of 1,4-dioxane. Therefore, the future groundwater monitoring event should include analysis of 1,4-dioxane at select wells near the source area and at select wells immediately downgradient of the source area, given 1,4-dioxane's highly mobile properties.

## **9.5 Technical Assessment: Area E Groundwater**

### **9.5.1 Question A**

*Is the remedy functioning as intended by the decision documents?*

Yes.

#### **9.5.1.1 Remedial Action Performance**

RCRA actions conducted in 1981 and the early 1990s removed most of the contaminant source in the soil. The ROD (USEPA, 2007) stated the timeframe to achieve the SCLs for COCs at Area E is

approximately 45 years. MNA sampling is currently being conducted annually, in accordance with the RD and program adjustments documented in the annual reports.

#### 9.5.1.2 Operations and Maintenance

Future groundwater use that could result in unacceptable risks to human health is controlled through the CEA and LUCs. The CEA is updated every two years and the LUCs are certified annually.

#### 9.5.1.3 Opportunities for Optimization

No opportunities for optimization were identified.

#### 9.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified.

#### 9.5.1.5 Implementation of Land Use Controls and Other Measures

The facility-wide CEA restricts use of groundwater at the site and the LUCs and engineering controls prohibit changes in the land use from what was assumed in the ROD. The LUCs and engineering controls are in place and inspected and certified annually.

### 9.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs (tapwater or industrial soil) and the applicable New Jersey standard (GWQC or NRDCSCC). Based on the comparison of SCLs in the ROD to RSLs and the applicable New Jersey standard, current groundwater and soil concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

Groundwater concentrations from 2015 were compared to the current, chemical-specific USEPA VISL calculator for commercial use. The USEPA risk calculations indicate the total HI is 0.8 and total carcinogenic hazard is  $8 \times 10^{-6}$ . Therefore, the conclusions from the ROD summarized in **Section 9.1.2** remain valid.

The RAOs remain valid as they prevent exposure to groundwater contaminants by human receptors. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment until the contaminated groundwater is restored to be usable as a potable water source.



### 9.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

#### 9.5.3.1 Ecological Risks

No new information concerning ecological risks was found during the review period that could call the protectiveness of the remedy into question.

#### 9.5.3.2 Natural Disasters

No natural disasters have occurred during the review period that could call the protectiveness of the remedy into question.

#### 9.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information was discovered that could call the protectiveness of the remedy into question.

### 9.5.4 Summary of Technical Assessment

The remedy has been implemented and is operating as intended by the ROD and RD. MNA sampling of groundwater and surface water is currently being conducted annually, in accordance with the RD and program adjustments documented in the annual reports. Annual LUC inspections and maintenance of the facility-wide CEA restricting groundwater use ensure LUCs remain effective at restricting potential exposure to contaminated groundwater. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

## 9.6 Issues: Area E Groundwater

No issues affecting the current or future protectiveness of the remedy were identified.

## 9.7 Recommendations and Follow-up Actions: Area E Groundwater

No recommendations that affect the current or future protectiveness of the remedy were identified.

### 9.7.1 Other Findings and Recommendations

As discussed in **Section 9.4.2**, the next groundwater monitoring event should include analysis of 1,4-dioxane at select wells near the source area and at select wells immediately downgradient of the source area.

As noted in **Section 9.4.2**, the variability in groundwater data particularly observed at E-95-3 suggests that further annual monitoring data are needed to estimate the remedial timeframe. The monitoring program could be reviewed for optimization opportunities, including locations and frequency. Statistical analysis could be conducted as part of the next FYR.

## **9.8 Protectiveness Statement: Area E Groundwater**

The remedy at Area E (PICA-077) Groundwater is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. MNA sampling of groundwater and surface water is currently being conducted annually, in accordance with the RD and program adjustments documented in the annual reports. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring systems is maintained, no unauthorized intrusive activities have occurred, existing ground covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 10.0 Site 180 (PICA-093) - Former Waste Burial Area

### 10.1 Background: Site 180

Site 180 (PICA-093) – Former Waste Burial Area is located in the north central portion of Area C at Picatinny and consists of approximately 6.8 acres on the eastern side of GPB (**Figure 10-1**). The site is a former waste burial area and is bounded by Site 34 (PICA-002) - Lower Burning Ground to the west, the Skeet Range to the north, and swampy wooded areas to the south and east. The Former Waste Burial Area is located within the 100-year floodplain of GPB, and high value wetlands comprise approximately 3 of its 6.8 acres.

The site is believed to have been used as an unregulated landfill in the 1960s and 1970s. Items which may have been deposited in the landfill include miscellaneous drums, debris, possible unexploded ordnance, railroad ties, telephone poles, concrete rubble, crushed steel drums, and miscellaneous building materials. Large portions of the southern end of Picatinny Arsenal were subject to filling activities to increase the amount of usable land.

#### 10.1.1 Site Chronology: Site 180

**Table 10-1: Chronology of Site Events at Site 180**

Event	Date
Phase I Remedial Investigation	1998
Exploratory Trench Investigation	1998 and 1999
Feasibility Study	2004
Proposed Plan	2006
Record of Decision	2007
Remedial Action Work Plan	2007
Annual Site Inspections	2007-2015
Fourth Five-Year Review (first for Site 180)	2011
Remedial Action Report	2009

#### 10.1.2 Initial Response

During the Phase I RI, propellant canisters and empty projectile bodies were discovered in three piles at the site. The Picatinny Environmental Affairs Office instituted a removal of this material in Spring 1997. The objective of the action was to enable sampling under the piles and to mitigate safety concerns regarding the propellant canisters. During the exploratory trench investigation in 1998 and 1999, mostly building debris and asbestos were discovered and subsequently removed.

#### 10.1.3 Basis for Taking Action

Based on the results of previous site investigations, COCs were not identified for subsurface soil and sediment. The 1998 HHRA determined these media do not pose unacceptable risks to human health and the environment and do not require remedial action. As stated in the ROD, surface water at the site is intermittent and therefore does not present an exposure pathway and does not support a viable aquatic

community on a year-round basis. Therefore, there is no unacceptable risk to human health or to ecological receptors associated with COCs in surface water.

Groundwater at Site 180 (PICA-093) - Former Waste Burial Area is being addressed as part of Area C (PICA-206) Groundwater and is presented in **Section 16**.

The contaminants in surface soil which were identified as COCs include:

- benz(a)anthracene
- benzo(a)pyrene
- benzo(b)fluoranthene
- benzo(k)fluoranthene
- chrysene
- dibenz(a,h)anthracene
- indeno(1,2,3-cd)pyrene
- arsenic
- cadmium
- copper
- lead
- zinc
- dieldrin
- PCBs (Aroclor-1254 and Aroclor-1260)

The HHRA (Dames and Moore, 1998) for the Former Waste Burial Area included exposure scenarios for the current outdoor maintenance workers, future industry/research workers, and future construction/excavation workers. The results of the HHRA indicated that under the current and hypothetical exposure scenarios excess lifetime carcinogenic risk posed by these COCs are within the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  and the HI is below 1 for the current land use. As discussed in **Section 4.6**, the Army chose to actively remediate the site based on the  $1 \times 10^{-6}$  risk level due to a specific request by the USEPA and the NJDEP to consider more active remediation at this site.

The ERA performed during the Phase I RI identified some ecological risks at the site relating to soil toxicity to earthworms and plant tissue bioaccumulation of aluminum and lead. A Risk Management Plan was completed to further evaluate the ecological risks and it was determined that the ecological risks are borderline and acceptable for all surface soil COPECs with the possible exception of chromium and selenium. No action was recommended to remediate these ecological risks because the remediation could result in more damage to the environment than the no-action alternative.

## **10.2 Remedial Actions: Site 180**

### **10.2.1 Remedy Selection**

The ROD for the Former Waste Burial Area was signed in September 2007. The RAOs for the site, as developed in the ROD, are:

- Protect industrial and recreational receptors from exposure to the site contaminants that results in unacceptable risk.

- Protect residential receptors from exposure to potential unacceptable risks from site contaminants.

The selected remedy, as detailed in the ROD, included implementation of LUCs to control disturbance of the site and to prevent any non-industrial use of the site. The selected remedy was chosen based on its protection of human health and the environment, the advantages of a minimally intrusive remedial alternative in the presence of high-value wetlands, and its effectiveness, short completion time, and low cost.

In addition to the LUCs selected for the majority of the site, the selected remedy also included construction of a cover system over the southwestern portion of site. This cover system extends from the Lower Burning Ground and did include the waste piles and buried debris areas in the southwestern portion of the Former Waste Burial Area. Details regarding the cover system extension were not addressed as part of the ROD for the Former Waste Burial Area but were included in the RD and RA phase of the Site 34 (PICA-002) - Lower Burning Ground remediation, discussed in **Section 19** of this report.

#### 10.2.2 Remedy Implementation

**Section 4.5.2** discusses LUCs utilized at Picatinny which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants. LUCs were implemented at the site in September 2007 in accordance with the approved RD. Remedy implementation included conducting a baseline site inspection and installing eleven signs along the boundary of the site prohibiting uncontrolled digging. A site map with the LUC area of applicability is included as **Figure 10-1**, and a figure showing the extent of the vegetative cover from Site 34 (the Former Burning Grounds) is included on **Figure 19-1**.

#### 10.2.3 Operation and Maintenance

Annual site inspections were initiated in December 2007 and continue to be completed on an annual basis. The presence of LUCs and the condition of the signs are also verified during the inspection, and, subsequently certified in Annual LUC Reports.

### 10.3 Progress Since Last Five-Year Review: Site 180

The fourth FYR was the first FYR performed after the ROD was signed in 2007. The protectiveness statement from the fourth FYR for the Former Waste Burial Area stated:

*The remedy for Site 180 (PICA-093) is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

Annual site inspections have been performed at the Former Waste Burial Area and subsequently certified in Annual Land Use Certification Reports. No additional actions have occurred at the Former Waste Burial Area since the previous FYR.

No issues or recommendations were identified in the previous FYR.

## **10.4 Document and Data Review: Site 180**

### **10.4.1 Document Review**

Relevant and appropriate documents associated with the Former Waste Burial Area investigations, remedy development, and operations were reviewed for this fifth FYR report. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2007a. Proposed Plan, Site 180 (PICA-093) – Waste Burial Area. February.

ARCADIS, 2007b. Final Remedial Action Work Plan, Site 180 (PICA-093) – Waste Burial Area. October.

ARCADIS, 2009. Final Remedial Action Report, Site 180 (PICA-093) – Waste Burial Area. June.

U.S. Army, 2007. Record of Decision, Site 180 (PICA-093) – Waste Burial Area. September.

### **10.4.2 Data Review and Evaluation**

No new data have been collected since the fourth FYR. Analytical data are not collected as part of the annual site inspections.

## **10.5 Technical Assessment: Site 180**

### **10.5.1 Question A**

*Is the remedy functioning as intended by the decision documents?*

Yes.

#### **10.5.1.1 Remedial Action Performance**

LUCs were the chosen remedy for the Former Waste Burial Area, no additional remedial actions have occurred at the site. LUCs at the site continue to function as intended by the decision documents.

#### **10.5.1.2 Operations and Maintenance**

The LUCs are properly maintained with repairs occurring as issues are identified, primarily replacing damaged signage. At minimum, deficiencies are noted during the annual LUC inspections and documented in the Annual Land Use Certification reports.

#### **10.5.1.3 Opportunities for Optimization**

The LUC inspection frequency has been adequate to ensure LUCs at the site function as intended by the decision documents. Therefore, no opportunities for optimization were identified during this FYR.

#### **10.5.1.4 Early Indicators of Potential Issues**

No early indicators of potential issues were identified during this FYR.

#### 10.5.1.5 Implementation of Land Use Controls and Other Measures

The LUCs have successfully eliminated unintentional exposure to site contaminants. The land use at the Former Waste Burial Area has not changed and no changes are expected in the near future which would impact the protectiveness of the remedy.

#### 10.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for industrial soil or the New Jersey NRDCSCC. Based on the comparison of SCLs in the ROD to RSLs and NRDCSCC, current soil concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This comparison is presented in **Appendix 4**.

The RAOs remain valid as they prevent unintentional exposure to human receptors of contaminated soils and minimize impacts to high-value wetlands. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment. The Annual LUC inspections have ensured land use remains consistent with what was assumed in the ROD.

#### 10.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

##### 10.5.3.1 Ecological Risks

No information concerning ecological risks was discovered during the review period that could call the protectiveness of the remedy into question.

##### 10.5.3.2 Natural Disasters

No natural disasters occurred during the review period that could call the protectiveness of the remedy into question.

##### 10.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information was found during the review period that could call the protectiveness of the remedy into question.

#### 10.5.4 Summary of Technical Assessment

The land use at the Former Waste Burial Area remains consistent with the assumptions made in the ROD. LUC inspections have occurred annually and none of the results have identified an issue which would impact the protectiveness of the remedy. The groundwater contamination is being addressed under the Area C ROD which is discussed in detail in **Section 16** of this FYR report. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

#### 10.6 Issues: Site 180

No issues which effect the protectiveness of the remedy at Site 180 (PICA-093) - Former Waste Burial Area have been identified during this fifth FYR.

#### 10.7 Recommendations and Follow-up Actions: Site 180

No recommendations or follow-up actions have been identified for Site 180 (PICA-093) - Former Waste Burial Area during this fifth FYR.

#### 10.8 Protectiveness Statement: Site 180

The remedy at Site 180 (PICA-093) - Former Waste Burial Area is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Construction of a soil cover at Site 34 Lower Burning Ground extended into the southwestern portion of Site 180 and included the waste piles and buried debris areas within Site 180. Annual LUC inspections have verified that signs remain in place, no unauthorized intrusive activities have occurred, existing surface covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective. As stated in the ROD, possible ecological risks are present at the site; however remediation could adversely impact high-value wetlands and result in more damage to the environment.



## 11.0 Green Pond and Bear Swamp Brooks (PICA-193)

Green Pond and Bear Swamp Brooks (PICA-193) include both Green Pond Brook (GPB) and Bear Swamp Brook (BSB) which represent the waterways which drain virtually all of Picatinny Arsenal. For the purpose of this section, this site and both brooks will collectively be referred to as GPB and BSB.

Numerous stormwater drainage structures exist on Picatinny Arsenal, many of which flow directly into GPB and BSB, including drop inlets with underground conduits, open channels located along road shoulders, and overland flow channels. GPB has received waste from historical operations at Picatinny Arsenal, including sewage and industrial wastewater discharges, stormwater runoff, and discharge from groundwater plumes.

BSB and the upper reaches of GPB in the study area flow through the industrial portion of Picatinny Arsenal. There are numerous buildings that border both brooks. In the past, many of these buildings had drains that discharged directly into the brooks. Currently, waste discharges to GPB and BSB no longer occur. The primary sources of contamination at GPB and BSB are past industrial activities at adjacent sites and stormwater drainage. Past operational activities include production of explosives, rockets, munitions, propellants, pyrotechnic signals and flares, fuses, and metal components.

There are environmental risks associated with elevated concentrations of metals, PCBs, pesticides, and semi-volatile organic compounds (SVOCs) that are present in sediment and surface water in Regions 2, 3, and 4 of GPB and BSB at Picatinny. GPB is approximately 22,440 linear feet and is the primary surface water drainage of Picatinny. BSB is approximately 4,400 linear feet and is a tributary of GPB. The stretch of GPB and BSB covered under this ROD is located throughout various areas of Picatinny including Areas A through H and Area P. **Figure 11-1** presents the location and site plan of GPB and BSB.

Numerous swampy areas and wetlands exist within the valley and are associated with the poorly drained glacial deposit soils. Some of these wet areas were drained because they were obstructing Picatinny activities. In 1944, dredging increased the hydraulic gradient of GPB. At the same time, field tile drainages were installed in the golf course area and numerous lateral drainage ditches were developed to help drain the wetland areas near the southern installation boundary. The drainage systems, installed as part of the reclamation activities, currently act as tributaries to GPB. These activities resulted in improved drainage and the reclamation of 360 acres of wetlands.

The size of the study area and large chemical analytical data set associated with GPB and BSB have made evaluation of the potential remedies complex. As a result, in order to properly define the scope and role of the GPB and BSB remedial action, the area was divided into four study areas or Regions based upon physical stream characteristics, proximity of industrial operations to the streams, and historic waste disposal documentation. Additionally, the lower region of GPB (below its confluence with BSB) may be receiving chemicals from both BSB and upstream GPB. Therefore, the intersection of GPB and BSB is a logical dividing point. The study area was divided into the following Regions (**Figure 11-1**):

- Region 1, GPB and Burnt Meadow Brook above Picatinny Lake
- Region 2, GPB below Picatinny Lake to the confluence with BSB (**Figure 11-2**)
- Region 3, BSB from Area H to the confluence with GPB (**Figure 11-3**)

- Region 4, GPB from the confluence with BSB to the southern boundary of Picatinny (**Figure 11-4**)

#### 11.1.1 Site Chronology: Green Pond and Bear Swamp Brooks

**Table 11-1: Chronology of Site Events at Green Pond and Bear Swamp Brooks**

Event	Date
ROD finalized	2005
Third Five-Year Review (first for GPB and BSB)	2006
Remedial Design finalized	2006
Chemical and Biological Sampling	2007
Response Action at GPB and BSB (PICA-193)	2007
Annual Chemical and Biological Sampling at Green Pond Brook and Bear Swamp Brook (PICA-193).	2008-2014
Fourth Five-Year Review (second for GPB and BSB)	2011

#### 11.1.2 Initial Response

Two removal actions have been completed in GPB and BSB prior to remedy selection. Both of these removals were conducted in Region 3 (BSB). The first was the removal of PCB sediment from the streambed and bank adjacent to Site 122 (Building 60) in early 2000. From January to May 2000, 387 CY (580 tons) of soil and sediment were removed and disposed off-site. The second removal action was the removal of sediment from the two sediment retention basins at Site 193, completed in 2003. Approximately 632 tons of stabilized sediment was disposed off-site as hazardous waste, and 386 tons of excavated soil was disposed as solid waste.

#### 11.1.3 Basis for Taking Action

The RI of GPB and BSB was conducted under several stages of the Phase and Phase II RIs between 1993 and 1998. One hundred and thirty six sediment samples and 101 surface water samples were collected in GPB and BSB. These sampling results indicated that past activities at Picatinny Arsenal had contaminated GPB and BSB. Due to the large area represented by GPB and BSB, they were broken into four study areas. A summary of COCs and SCLs organized by region and media is presented **Table 11-2**.

For surface water, the HHRA (Dames and Moore, 1998) for GPB and BSB (PICA-193) included exposure scenarios for the trespass swimmers and consumers of recreationally caught fish. The estimated human health risk for recreational trespassers was in the generally accepted risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  and the HI was below 1. The estimated human health risk for the fish consumer was above  $1 \times 10^{-4}$  but was likely overestimated because Picatinny prohibits fishing in the majority of GPB. Consumption of fish that have migrated off-site would have less exposure to site-related contaminants than the evaluated on-site exposure that is addressed and found to be acceptable given the uncertainty and conservative nature of the risk assessment. Thus, the remedy is protective of this pathway. The transport of chemicals in surface water downgradient to a drinking water source could only be minimal. This is considered an insignificant exposure route. As a result, human health risks are not driving the active remedial actions discussed in this document. The basis for the RAs selected in the ROD is to

formalize LUCs and to reduce the potential for unacceptable risk to ecological receptors. RAOs associated with surface water will be eventually satisfied through remedial alternatives developed for contaminated sediment and through site-specific FSs and decision documents developed for individual sites at Picatinny.

A BERA of GPB and BSB was conducted from a watershed perspective (rather than a site-specific basis) during the Picatinny Phase I RI (Dames & Moore, 1998). The BERA concluded there did not appear to be contaminant-related impacts in GPB despite the presence of elevated levels of contaminants in sediment at certain locations and, occasionally, in surface water, and some observed bioaccumulation of select contaminants in fish tissue. There is potential for adverse effects to mink, great blue heron, and the ecological receptors in the GPB study area, although the modeling results appear to be conservative. The BERA concluded the following:

- No observable impacts to the plant community
- Plant tissue data suggest modest bioaccumulation of aluminum and lead
- Soil slightly toxic to earthworms
- Small mammal population data suggest no apparent impact
- No meaningful bioaccumulation observed in small mammals

While the LUCs associated with Site 190 are not protective of ecological receptors, based on the borderline and acceptable risks to ecological receptors (the veery, woodcock and barred owl) and the presence of wetlands that cover half of the site and surrounding area, it is expected that an active remedial method would likely produce more adverse impacts to both the ecological receptors and environment than ICs and land use restrictions. The site risk under the range of likely future use scenarios is minimal and the selected remedy provides an optimum balance between the protection of human health and minimizing intrusion into the well-established wetlands and upland habits.

## **11.2 Remedial Actions: Green Pond and Bear Swamp Brooks**

### **11.2.1 Remedy Selection**

The ROD for GPB and BSB was signed by the USEPA on July 18, 2005. Interim RA measures were conducted in 2000 and 2003, as described in **Section 11.1.2**, and the Final RA began in 2007. RAOs were identified on a Region specific basis.

#### ***Region 1***

There are no COCs for Region 1

#### ***Region 2***

The RAOs listed in the ROD for Region 2 are as follows:

- Implement alternatives that can effectively reduce the risks to potential ecological receptors caused by the COCs present at the areas of concern (AOCs)

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- Limit human exposure to elevated levels of contaminants in sediment and surface water (Note: Based on a restricted use scenario, there is no unacceptable risk to human health in Region 2 from levels of contaminants in sediment and surface water)
- Protect areas downstream of Region 2 from migration of COCs at levels that could potentially impact ecological receptors
- Avoid disturbance of aquatic habitat in Area G where impacts to ecological receptors are uncertain

The selected remedy for Region 2 is:

- Chemical monitoring of surface water and sediment for metals, SVOCs, pesticides and PCBs; and, biological monitoring (benthic macroinvertebrate studies and toxicity testing studies)
- Collection and analysis of deep-sediment samples at the AOCs to verify there are no zones of contamination in deeper sediments that could be released in the future. If sample results indicate deep sediment contamination that could be mobilized in the future, the remedy for this region will be reviewed to determine whether the monitoring program needs to be adjusted or more active remedial measures taken
- Implementation of LUCs to ensure protectiveness

### Region 3

The RAOs listed in the ROD for Region 3 are as follows:

- Mitigate the impact to ecological receptors in the sediment retention ponds and the area near Site 128
- Avoid disturbances of high-quality habitat in Area H
- Limit human exposure to elevated levels of contaminants in sediment and surface water (Note: Based on a restricted use scenario, there is no unacceptable risk to human health in Region 3 from levels of contaminants in sediment and surface water)
- Prevent contaminants in Region 3 from impacting better quality habitat in Region 4.

The selected remedy for Region 3 is:

- Excavation and on-site stabilization of contaminated sediment from the oil/water separator pond, and the stream tributary adjacent to Site 128
- Chemical monitoring of surface water and sediment for metals, PAHs, pesticides and PCBs; and, biological monitoring (benthic macroinvertebrate studies and toxicity testing studies)
- Collection and analysis of deep-sediment samples at the AOCs to verify there are no zones of contamination in deeper sediments that could be released in the future. If sample results indicate deep sediment contamination that could be mobilized in the future, the remedy for

this region will be reviewed to determine whether the monitoring program needs to be adjusted or more active remedial measures taken

- Implementation of LUCs

#### ***Region 4***

The RAOs listed in the ROD for Region 4 are as follows:

- Reduce risks to potential ecological receptors by implementing remedial alternatives for COC source areas selected through Site 34 and Site 20/24 FSs;
- Prevent contaminants in Region 4 from impacting better quality habitat off-site; and,
- Limit human exposure to elevated levels of contaminants in sediment and surface water (Note: Based on a restricted use scenario, there is no unacceptable risk to human health in Region 4 from levels of contaminants in sediment and surface water).

The selected remedy for Region 4 is:

- Chemical monitoring of sediments for metals; and, biological monitoring (benthic macroinvertebrate studies);
- Collection and analysis of deep-sediment samples at the AOCs to verify there are no zones of contamination in deeper sediments that could be released in the future. If sample results indicate deep sediment contamination that could be mobilized in the future, the remedy for this region will be reviewed to determine whether the monitoring program needs to be adjusted or more active remedial measures taken; and,
- Implementation of LUCs.

#### **11.2.2 Remedy Implementation**

Contaminated sediments were removed from two separate areas as part of the remedial action activities completed in September 2007. Approximately 185 tons of impacted sediments were excavated from the oil/water separator in the lower section of BSB, and approximately nine tons of mercury impacted sediments were excavated from an unnamed tributary of BSB located within Site 128.

Remedial actions at Site 31/101 (PICA-72), discussed in **Section 15**, have also been conducted in order to improve sediment quality at location GPBSD-26 in Region 2 (**Figure 11-2**). As part of the RA for Site 31/101 (PICA-72), approximately 1,700 CY of metals-impacted soils adjacent to location GPBSD-26 were excavated and the area was backfilled with common borrow and topsoil.

Chemical and biological monitoring were initiated in 2007. In Regions 2, 3, and 4 the remedial activities included the collection and chemical analysis of both shallow and deep sediment samples, as well as the collection and biological analysis of sediment samples as part of a LTM program. The deep sediment samples confirmed there were no zones of contamination in deeper sediments that could be released in the future. Thus this deep sediment sampling was discontinued from the sampling program

in accordance with the ROD and RD. Annual chemical and biological sampling continued from 2011 through 2014. At the time of this review, the 2015 annual monitoring report was unavailable for review.

**Section 4.5.2** discusses LUCs utilized at Picatinny which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants. LUCs were implemented in 2007 as part of this remedial action. A site-wide Land Use Certification was prepared at the close of 2007 and was approved by the USEPA on April 16, 2008. LUCs have been certified annually during this review period (2011 through 2015).

### 11.2.3 Operation and Maintenance

Site inspections have occurred during the review period on an annual basis to confirm continued compliance with all LUC objectives. The site inspections evaluate the condition of excavated areas and signs, review for inappropriate land use, such as intrusive activities or construction, and facility-wide LUCs described in **Section 4.5**.

The LTM for GPB and BSB includes annual chemical and biological monitoring, as summarized in **Table 11-3** and with sampling locations presented on **Figure 11-2** (Region 2), **Figure-11-3** (Region 3), and **Figure 11-4** (Region 4). LTM activities and sampling were collected during the review period (2011 through 2014) in accordance with RD. Chemical monitoring consists of sediment and surface water samples, while biological monitoring consists of samples of the benthic macroinvertebrate communities as well as sediment samples for biological toxicity testing. The annual sampling of sediment, surface water, and biota was proposed in the FS and subsequent documents.

**Table 11-3: Summary of LTM Sampling and Analyses**

Sampling Locations	Number of Sampling Locations			Analyses		
	Sediment	Surface Water	Biological	Chemical	Biological	
					Benthic Macro.	Sediment Toxicity
Reference Locations	2	--	2	A	C	D
Region 2	4	--	3	A	C	D
Region 3	3	--	1	A	C	D
Region 4	3	1	1	A, B	C	D

Notes:

- A- Sediment chemical analyses: pesticides, PCBs, metals, PAHs, SVOCs
- B- Surface water chemical analyses: pesticides, PCBs, metals, PAHs, SVOCs, and VOCs, and collection of field parameters
- C- benthic macroinvertebrate
- D- Hyalella azteca 28-Day Study, Chironomus dilutus Long-Term Exposure Study

Analytical results are evaluated using the following assessments:

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- Habitat assessment at each location is based on physical inspection of sampling locations; 10 metrics are used to assign a numerical score between 0-20. A final habitat assessment of optimal, suboptimal, marginal or poor is assigned after tallying the scores from the 10 metrics.
- Biological quality is evaluated using benthic macroinvertebrate data and the High Gradient Macroinvertebrate Index (HGMI). Conditions are rated as excellent, good, fair, or poor.
- Sediment toxicity is evaluated based on the results from the *Hyaella Azteca 28-day study* (mean survival and growth) and *Chironomus Dilutes Long-Term Exposure Study* (adult emergence and total survival). Statistical analysis (ANOVA) is used to distinguish the differences between the control and test results

The overall objective of LTM is to ensure that implementation of RAs at the sedimentation basins, Site 128, and the oil/water separator continue to provide adequate protection of human health and the environment and that the levels of contamination and potential ecological risk in all regions of GPB and BSB continue to improve.

### **11.3 Progress Since Last Five-Year Review: Green Pond and Bear Swamp Brooks**

The protectiveness statement from the fourth FYR was:

*The remedy for GPB and BSB (PICA-193) is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

There were no issues or recommendations in the fourth FYR. Annual sediment and surface water sampling continued throughout the FYR period.

### **11.4 Document and Data Review: Green Pond and Bear Swamp Brooks**

#### **11.4.1 Document Review**

Relevant and appropriate documents associated with the GBP investigations, remedy development, and operations were reviewed for this fifth FYR. Key documents reviewed included:

Green Pond Brook and Bear Swamp Brook (PICA-193). Record of Decision. July 2005

Bear Swamp Brook Oil/Water Separator and Tributary Stream Sediment Removal Action Work Plan. Shaw Environmental Inc. March 2007.

Final Interim Remedial Action Report, Green Pond Brook/Bear Swamp Brook (PICA-193) U.S. Army Garrison Picatinny Arsenal. New Jersey, December 2008

2013 Annual Surface Water and Sediment Monitoring Report: Green Pond Brook and Bear Swamp Brook (PICA-193) U.S. Army Garrison Picatinny Arsenal, New Jersey , June 2014

2014 Annual Surface Water and Sediment Monitoring Report: Green Pond Brook and Bear Swamp Brook (PICA-193) U.S. Army Garrison Picatinny Arsenal, New Jersey , November 2014

#### 11.4.2 Data Review and Evaluation

The Removal Action Work Plan was amended in the 2011 and 2013 Annual Surface Water and Sediment Monitoring Reports (ARCADIS, 2012, ARCADAS 2013, and ARCADIS, 2014; respectively), chemical and biological samples were collected from Reference Locations, Region 2, Region 3, and Region 4.

A single surface-water sample is collected annually in Region 4. The surface-water sample is analyzed for pesticides, PCBs, inorganics, PAHs, SVOCs and VOCs. No COCs were identified in Region 4 surface water and SCLs were not formally established in the ROD. Therefore, contaminant concentrations are compared to the LOC rather than SCLs. For surface water, the promulgated New Jersey Surface-Water Quality Criteria (NJSWQC) was selected as the LOC for preliminary screening criteria. If state criteria were absent, the USEPA Water Quality Criteria were selected as LOCs. Results are included in **Table 11-4** and discussed under Region 4 below.

Chemical and biological monitoring results from the October 2011, October 2012, October 2013, and 2104 sampling events are included in the 2014 annual report which provides a comprehensive summary of results from 2007 to 2014. Chemical data trend plots depicting 2007 through 2014 (included as Appendix B-1 of 2014 annual report) were also reviewed and included on **Figure 11-5** of this report.

All significant decreasing or increasing trend patterns are summarized below for each region.

##### **Reference Locations:**

- The results of chemical data for reference sediment samples are presented in Appendix A-1 of the 2014 annual report. No COCs were identified in reference areas and no non-COCs were detected at concentrations exceeding potential effects levels or ecologically-based screening criteria.
- The results of biological indicate both locations achieved a full attainment regulatory threshold; however both reference locations show a gradual decline in water quality ratings.

##### **Region 2 Locations:**

- Four sediment samples were collected for chemical analysis from locations 31SD-4, SD52-5, GPBSD-26 and SD101-1. Twelve COCs were identified for Region 2 however, only two COCs, copper and arsenic, exceeded their respective RGs during the most recent sampling event.
- Three biological samples, consisting of benthic macroinvertebrate and surface sediment samples, were collected in Region 2. Habitat scores remained relatively consistent over the eight sampling periods at all Region 2 sample locations; however, the results of the most recent sampling event represent the best ratings for water quality and biological assessment/condition for GPBSD-26, to date.
- Toxicity observed at Region 2 sample location GPBSD-26 in 2014 may be related to elevated concentrations of COCs observed in sediment at this location. Toxicity observed at the remaining sample locations may be related to causes other than elevated COC concentrations



(i.e., physical sediment properties [pH, moisture, grainsize], non-COC chemicals and parameters, manipulation and/or storage of sediment samples.

### Region 3 Locations:

- A total of three sediment samples were collected for chemical analysis from locations SDBS-25, SDBS-23 and BSSD-29. Thirteen COCs were identified for Region 3. Three COCs including copper, chromium, and cadmium, exceeded their respective SCL for the most recent sampling event.
- One biological sample, consisting of benthic macroinvertebrate and surface sediment samples, was collected in Region 3. Habitat scores (derived from the habitat evaluations), water quality ratings (derived from the HBI metric), and biological condition (derived from the HGMI), were consistent with previous sampling.

### Region 4 Locations:

- Stable or decreasing concentrations of copper, the only COC identified in Region 4, from 2011 through 2014 were observed at Region 4 sample locations.
- Biological monitoring results from the October 2011, October 2013, and 2014 were compared the habitat scores remained sub-optimal throughout the review period and the results were consistent with previous sampling events. Samples were not collected in Region 4 in 2012.
- No COCs were identified in Region 4 surface water; however, in 2013, six non-COCs exceeded LOCs including iron, sodium, pesticides (dichlorodiphenyldichloroethane, 4,4'-dichlorodiphenyldichloroethylene [4,4'-DDE], and 4,4'-DDT), and TCE. In 2014 TCE was detected at a concentration slightly exceeding its LOC of 1 µg/L at sample location 34SW-8 (1.01 µg/L )

Other observations include the following:

- A review of the chemical data trend plots on **Figure 11-5**, show the majority of COC concentrations appear to be stable or decreasing. Anomalous detections of COCs at elevated concentrations have been identified during monitoring events at certain sampling locations, including chromium at SDBS-25, zinc at SD52-5, 4,4'-DDE at GPBSD-26, aroclor-1254 at SDBS-25, and SVOCs at 31SD-4. These single detections do not correspond to observed spatial or temporal trends, and sample results generally return to levels consistent with the observed trends in subsequent annual monitoring events.
- COCs exceeded RGs in Region 2 and Region 3. In Region 2, copper was detected at concentrations exceeding its RG of 260.8 mg/kg at sample GPBSD-26 (8,130 mg/kg) in 2014, which is consistent with previous exceedances from 2007 through 2012. In 2014, arsenic was also detected at concentrations exceeding its RG of 22 mg/kg for only the second time at sample location SD101-1 (28.3 mg/kg), as shown in **Table 11-5**. In Region 3 chromium, cadmium, and copper exceeded the RGs in 2014. The results are included in **Table 11-6**. There were no exceedences in Region 4. These results are included in **Table 11-7**.

- All biological sample locations, with the exception of reference location GPB-2, had less than optimal habitat ratings throughout the review period. All biological sample locations, with the exception of the reference locations, have been classified as moderately to severely impaired (macroinvertebrate sampling) throughout the majority of the eight year sampling program. The impaired conditions observed in the benthic macroinvertebrate community assessments may be the result of physical alterations in the habitat (e.g., sedimentation, scouring caused by higher runoff peaks associated with urbanization, low summer flows, and elevated summer water temperatures) rather than chemical contamination.
- All sample locations, with the exception of GPBSD-26 had fair biological assessment ratings and a non-attainment regulatory threshold. Regions 2 sample location GPBSD-26 improved to a good biological assessment rating and a full attainment regulatory threshold in 2014 for the first time.
- In the previous (Fourth) FYR, sample location GPBSD-26 was the single location where COCs exceeded RGs, and toxicity test results showed acute toxicity. In addition, the macroinvertebrate community was rated as severely impaired in 2009, similar to the rating in 2007 (2008 showed moderately impaired rating). In 2009 a removal action was completed in the vicinity of GPBSD-26, and metals in sediments at GPBSD-26 reduced significantly until the 2014 event. In 2014, copper was detected above its RG (260.8 mg/kg) at sample location GPBSD-26. However the exceedance in 2014 (8,130 mg/kg) is still an order of magnitude lower than the maximum exceedance in 2007 (73,500 mg/kg), and last previous exceedance in 2009 (11,600 mg/kg). In 2015 copper dropped back down to 995 mg/kg. In 2013 GPBSD-26 had fair biological assessment ratings and a non-attainment regulatory threshold. In 2014, GPBSD-26 had an HGMI of 45.3, a biological condition of good, and a full attainment regulatory threshold, which is better than reference location 1515R-2 and equal to reference location GPB-2. This is the best ratings for water quality and biological assessment/condition for GPBSD-26, to date.
- The 2014 annual report indicated that GPB-2, one of the two reference sample locations, has been showing a declining trend in water quality from the 2007 sampling period through the 2014 sampling period. This is mentioned in multiple annual reports; however it does not specify the cause of the declining trend in water quality.

## **11.5 Technical Assessment: Green Pond and Bear Swamp Brooks**

### **11.5.1 Question A**

*Is the remedy functioning as intended by the decision documents?*

Yes.

#### **11.5.1.1 Remedial Action Performance**

A series of removal actions have been completed to address the areas of GPB and BSB which posed the greatest risk to ecological receptors. LTM shows that current conditions are generally consistent with previous results (2007 through 2014), and contaminant concentrations are largely decreasing over time. Per the RD, further removal actions or more active remedial actions are to be considered if all of the criteria (RG exceedances, toxicity, and benthic impairment) for potential biological impacts are

observed over a consecutive two-year period. To date, these conditions have been observed at only one of the sampling locations. As a results, an additional removal action was conducted in 2009 adjacent to this location, and COC contaminations have decreased substantially thus helping to improve sediment quality in this Region.

#### 11.5.1.2 Operations and Maintenance

Biological and chemical monitoring has been performed consistent with the RD. Site inspections were conducted on an annual basis during the review period to confirm continued compliance with all LUC objectives. One of the LUC objectives includes prohibiting the development of property within 25 feet of GPB/BSB limiting human exposure to elevated levels of contaminants in the surface water by prohibiting fishing, swimming, and/or recreational activities in and around GPB/BSB. Picatinny ICs, enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures have remained in place.

#### 11.5.1.3 Opportunities for Optimization

No opportunities for optimization were identified.

#### 11.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were observed.

#### 11.5.1.5 Implementation of Land Use Controls and Other Measures

The LUCs are in place and functioning as intended. LUCs and annual site inspections have been effective in limiting potential exposure to site contaminants and ensuring no changes in land use have occurred.

### 11.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for industrial soil and the New Jersey NRDCSCC. Based on the comparison of SCLs in the ROD to RSLs and NRDCSCC, current soil concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

The RAOs remain valid as they eliminate unacceptable risks to human health and ecological receptors. The RAOs are delineated by Region within GPB and BSB to ensure specific habitats are protected. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment.

### 11.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

#### 11.5.3.1 Ecological Risks

No further information has been developed that could call into question the protectiveness of the remedy.

#### 11.5.3.2 Natural Disasters

No natural disasters have occurred that could call into question the protectiveness of the remedy.

#### 11.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No further information has been developed that could call into question the protectiveness of the remedy.

### 11.5.4 Summary of Technical Assessment

The remedy has been implemented and is operating as intended by the ROD and RD. Chemical and biological monitoring has been conducted within Region 2, 3, and 4, in accordance with the LTM program outlined in the RD and program adjustments documented in the annual reports. A series of removal actions have improved sediment quality, and the LTM program has been used to identify areas where sediment removal is beneficial. Annual LUC inspections have been effective in documenting land use and compliance with the LUCs. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### 11.6 Issues: Green Pond and Bear Swamp Brooks

No issues which effect the protectiveness of the remedy at GPB and BSB (PICA-193) have been identified during this fifth FYR.

### 11.7 Recommendations and Follow-up Actions: Green Pond and Bear Swamp Brooks

No recommendations or follow-up actions have been identified for the GPB and BSB (PICA-193) during this fifth FYR.

### 11.8 Protectiveness Statement: Green Pond and Bear Swamp Brooks

The remedy at Green Pond and Bear Swamp Brooks (PICA-193) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Chemical monitoring within sediment and surface water and biological monitoring have been conducted within Region 2, 3,

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and 4, in accordance with the LTM program outlined in the RD and program adjustments documented in the annual reports. A series of removal actions have improved sediment quality, and the LTM program has been used to identify areas where sediment removal is beneficial. Annual LUC inspections have been effective in limiting exposure to site contaminants. Annual site inspections were conducted to confirm continued compliance with all LUC objectives which include prohibiting the development of property within 25 feet of GPB/BSB and prohibiting fishing, swimming, and/or recreational activities in and around GPB/BSB. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 12.0 Group of 11 Sites (PICA-020)

### 12.1 Background: Group of 11 Sites

Group of 11 Sites (PICA-020), originally referred to as the Group of 13 Sites, addresses the soils at 13 sites located in five areas at Picatinny (**Figure 12-1** through **Figure 12-11**). Two sites were determined to require No Further Action (NFA): Site 44 (PICA-083) - Golf Course Maintenance Shop and Site 49 (PICA-088) - Building 19 and Building 19A, Former 90-Day Waste Accumulation Area. The removal of the two NFA sites reduced the original 13 sites to the current Group of 11 Sites. The Group of 11 Sites, separated by area, consist of the following:

#### Area C

- Site 19 (PICA-020) - Former Pyrotechnic Demonstration Range **Figure 12-1**
- Site 163 (PICA-092) - Baseball Fields **Figure 12-2**

#### Area D

- Site 86 (PICA-095) - Former Photo Processing Facility **Figure 12-3**
- Site 182 (PICA-099) - Building 5, Former Arsenal Reproduction **Figure 12-4**
- Site 183 (PICA-100) - Former Arsenal Reproduction and Training **Figure 12-5**

#### Area E

- Site 28 (PICA-070) - Sewage Treatment Plant Former Sludge Beds **Figure 12-6**

#### Area F

- Site 106 (PICA-036) - Former Building 1010, Propellant Plant **Figure 12-7**
- Site 124 (PICA-105) - Former Building 166, Propellant Testing **Figure 12-8**
- Site 141 (PICA-110) - Building 429, Propellant Crushing **Figure 12-9**
- Site 143 (PICA-112) - Building 436, Propellant Processing **Figure 12-10**

#### Area G

- Site 135 (PICA-118) - Buildings 315 and 316, Metallurgical Laboratory and Former Laboratory **Figure 12-11**

The Group of 11 Sites is used for industrial purposes except Site 163 (PICA-092) - Baseball Fields, which is used for recreation. The use of the Baseball Fields for recreation was evaluated in the risk assessment performed on the site and summarized in the ROD. The future land uses planned for most the Group of 11 Sites will ultimately remain as industrial as specified in the most recent Master Plan for Picatinny Arsenal. The Baseball Fields have been identified for three potential future uses: as a wetland, as a location for a high-tech research center, or for a hotel as part of the planned public/private partnership.

Descriptions of each of the Group of 11 Sites, as well as the two NFA sites, are included in **Appendix 5**.

#### 12.1.1 Site Chronology

**Table 12-1: Chronology of Site Events at Group of 11 Sites**

Event	Date
LUC signage installed and GIS system updated	2007
ROD signed by EPA	2008
Remedial Action Work Plan approved by EPA	2008
Annual Land Use Certification	2007-2015
Fourth Five-Year Review (first for Group of 11 Sites)	2011

### 12.1.2 Basis for Taking Action

Based on the results of previous site investigations, contaminants were evaluated only for the current and reasonably anticipated future use. No COCs were identified at any of the original 13 sites included in PICA-020. A 1998 HHRA for the sites included exposure scenarios for the current outdoor maintenance workers, future industry/research workers, and future construction/excavation workers based on site specific concentrations of metals, PCBs, and SVOCs which exceeded comparison criteria. A land use scenario for current child baseball players was also included for Site 163 (PICA-092). The results of the HHRA indicated that under the current and hypothetical exposure scenarios, the excess lifetime carcinogenic risk posed by contaminants was within the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  and the HI is below 1 for the current land use at each of the original 13 sites. As discussed in **Section 4.6**, the Army chose to develop a RA at the site based on the  $1 \times 10^{-6}$  risk level due to a specific request by the USEPA and the NJDEP to consider more active remediation at this site.

Site data was evaluated to determine if an ERA was necessary. BERAs were performed for sites having adequate habitat and the potential for a completed ecological receptor pathway. The majority of these sites consist of buildings in an urban setting, a pair of baseball fields, and heavily disturbed areas. Therefore, ERAs were not conducted at 12 of the 13 sites. An ERA was conducted at PICA-070. The ERA determined four metals (arsenic, chromium, lead, and zinc) have maximum HQs above 1. The findings show that the risks are based on local samples and conservative for the woodcock and; thus do not represent a risk for birds living in the surrounding forests.

## 12.2 Remedial Actions: Group of 11 Sites

### 12.2.1 Remedy Selection

The ROD for the Group of 13 Sites was signed by the U.S. Army on July 3, 2008 and by the USEPA on September 30, 2008. The RAO listed in the ROD for the sites is as follows: maintain current land use (industrial) and current ICs.

The selected RA for Sites 19, 163, 86, 182, 183, 28, 106, 124, 141, 143, and 135 was implementation of LUCs to maintain the current use of the sites (industrial). Site 49 and 44 did not require a RA and were approved for NFA.

### 12.2.2 Remedy Implementation

**Section 4.5.2** discusses LUCs utilized at Picatinny which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants. Nineteen signs were installed between

September 10 and 24, 2007. The signs were installed along the boundary of the site prohibiting uncontrolled digging. Site maps and LUCs area of applicability are depicted on **Figure 12-1** through **Figure 12-11**.

#### 12.2.3 System Operations/O&M

Annual site inspections were initiated in December 2007 and continue to be performed on an annual basis. The presence of LUCs and the condition of the signs are also verified during the inspection and subsequently certified in Annual Land Use Certification Reports.

### 12.3 Progress Since Last Five-Year Review: Group of 11 Sites

The Fourth FYR was the first time the Group of 11 Sites was included in a FYR Report. The protectiveness statement from the last review stated:

*The remedy for the Group of 13 Sites (PICA-020) is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

No issues or recommendations were identified in the previous FYR report.

Annual site inspections have been performed at the Group of 11 Sites and subsequently certified in Annual Land Use Certification Reports. The 2013 Annual Land Use Certification Report identified intrusive activities which took place at Building 166 (PICA-105, Site 124) as part of the a schedule demolition of Building 166. The demolition activity occurred in accordance with the LUCs for the site and in coordination with the Picatinny Arsenal Environmental Office. No additional actions have occurred at the Group of 11 Sites since the previous FYR.

### 12.4 Document and Data Review: Group of 11 Sites

#### 12.4.1 Document Review

Relevant and appropriate documents associated with the Group of 11 Sites (PICA-020) investigations, remedy development, and operations were reviewed for this Fifth FYR report. Site documents can be located at the Picatinny Arsenal website. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2008. Final Remedial Action Work Plan, PICA-020 Group of Sites. Picatinny Arsenal, New Jersey. October.

ARCADIS, 2009. Final Remedial Action Report, PICA-020 Group of Sites. Picatinny Arsenal, New Jersey. June.

U.S. Army, 2008. Record of Decision, PICA-020 Group of Sites. September.



#### 12.4.2 Data Review and Evaluation

Chemical data is not collected as part of the remedy at the Group of 11 Sites. Annual LUC inspections are conducted to document the condition of the sites and to verify no changes in land use or intrusive activities have occurred. Site specific LUCs are in effect and are protective of human health and the environment, as documented in the 2011, 2012, 2013, and 2014 annual LUC inspection certification reports.

### 12.5 Technical Assessment: Group of 11 Sites

#### 12.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

##### 12.5.1.1 Remedial Action Performance

LUCs were the chosen remedy for the Group of 11 Sites, no additional remedial actions have occurred at the sites. LUCs were determined to be protective of human health and the environment in the ROD based on the continued industrial land use of the sites. Land use at the sites has not changed and the LUCs ensure risks to human health and the environment remain within acceptable limits. The remedy is functioning as intended by the decision documents.

##### 12.5.1.2 Operations and Maintenance

The LUCs are properly maintained with repairs occurring as issues are identified, primarily replacing damaged signage. At minimum, deficiencies are noted during the annual LUC inspections and documented in the Annual Land Use Certification reports.

##### 12.5.1.3 Opportunities for Optimization

The LUC inspection frequency has been adequate to ensure LUCs at the Group of 11 Sites remain protective of human health and the environment. Therefore, no opportunities for optimization were identified during this FYR.

##### 12.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified during this FYR.

##### 12.5.1.5 Implementation of Land Use Controls and Other Measures

The RAO for the Group of 11 Sites, as stated in the ROD, is to maintain the current industrial land use and the current ICs. LUCs were implemented for the Group of 11 Sites to ensure that no unacceptable risk to human receptors occurs in the future. LUC certifications have been performed annually since the remedy was implemented.

#### 12.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy.

The RAO for the Group of 11 Sites remains valid as the Army maintains the current industrial land use and the ICs. LUCs were implemented for the Group of 11 Sites to ensure that no unacceptable risk to human receptors occurs in the future. LUC certifications have been performed annually since the remedy was implemented.

#### 12.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No.

##### 12.5.3.1 Ecological Risks

No information concerning ecological risks was discovered during the review period that could call the protectiveness of the remedy into question.

##### 12.5.3.2 Natural Disasters

No natural disasters occurred that could call the protectiveness of the remedy into question.

##### 12.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information came to light during the review period that could call the protectiveness of the remedy into question.

#### 12.5.4 Summary of Technical Assessment

The LUCs at the Group of 11 Sites have been inspected annually and remain protective of human health and the environment. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. The RAO ensures the land use remains industrial and thereby restricts potential exposure to contaminated soils. Exposure assumptions made in the ROD remain valid and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### 12.6 Issues: Group of 11 Sites

No issues which effect the protectiveness of the remedy were identified for the Group of 11 Sites during this FYR.

## **12.7 Recommendations and Follow-up Actions: Group of 11 Sites**

No recommendations or follow-up actions were identified for the Group of 11 Sites during this FYR.

## **12.8 Protectiveness Statement: Group of 11 Sites**

The remedy at the Group of 11 Sites (PICA-020, Site 19) is protective of human health and the environment.

The remedy's RAO to maintain current land use (industrial) and current ICs is being met. Annual land use monitoring inspections have verified that signs remain in place, no unauthorized intrusive activities have occurred, existing surface covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 13.0 Site 61/104 (PICA-102) – Former Waste Dumps and Chemical Laboratories

### 13.1 Background: Site 61/104

Site 61/104 (PICA-102) are centrally located within Picatinny Arsenal, as part of Area F, and are adjacent to GPB (**Figure 13-1**).

#### Site 61

Site 61 is located on Sixteenth Avenue northwest of the intersection of Ninth Street and Buffington Road. Site 61 encompasses approximately three acres and includes Buildings 171 and 176. The basement of Building 171 has historically been used as a photographic laboratory. Building 176 was historically used for laboratory equipment storage and ammunition sampling. Currently, Buildings 171 and 176 are used for administrative purposes.

#### Site 104

Located south of Site 61, with GPB to the west, Site 104 occupies an area of approximately 0.96 acres and includes former Building 161 and Building 162. Former Building 161 was located on Kibler Road, southwest of Building 162 and was used as a railroad scale house. Former Building 161 was demolished sometime prior to 1942. Building 162 is located on Kibler Road and is presently used for administrative purposes. The primary operations conducted at the building in the past included propellant and ammunition analyses. Historical practices at Building 162 include chemical disposal in sewers and sinks, using carbon tetrachloride (CT) and mercury for cleaning purposes, and the dumping of chemicals and propellants into the swampy area west of the building.

#### 13.1.1 Site Chronology

**Table 13-1: Chronology of Site Events at Site 61/104**

Event	Date
Site Investigations	1993-2000
Feasibility Study (Sites 61 and 104)	2005
Record of Decision (Sites 61 and 104)	2008
Remedial Action Work Plan (Sites 61 and 104)	2008
Remedial Action Report (Sites 61 and 104)	2009
Annual Site Inspections and Land Use Certification	2008-2015
Fourth Five-Year Review (first for Site 61/104)	2011

#### 13.1.2 Basis for Taking Action

Based on the results of previous site investigations, COCs were identified for surface soil, subsurface soil and sediment. As stated in the ROD, no COCs were identified in surface water at the site and groundwater at Site 61/104 (PICA-102) is being addressed as part of Mid-Valley Groundwater (PICA-204).

The contaminants in surface soil, subsurface soil, and sediment which were identified as COCs include:

- arsenic;
- beryllium;
- chromium (sediment only);
- copper;
- lead;
- nickel (sediment only);
- silver (sediment only);
- thallium;
- zinc;
- acenaphthylene (sediment only);
- benz(a)anthracene;
- benzo(a)pyrene;
- benzo(b)fluoranthene;
- benzo(k)fluoranthene;
- dibenz(a,h)anthracene;
- flouranthene (sediment only);
- indeno(1,2,3-cd)pyrene;
- phenanthrene (sediment only);
- pyrene (sediment only);
- heptachlor epoxide (sediment only); and
- 4,4'-DDE.

The 1998 HHRA for Site 61/104 (PICA-102) included exposure scenarios for the current outdoor maintenance workers, future industry/research workers, and future construction/excavation workers. The results of the HHRA indicated that under the current and hypothetical exposure scenarios, the excess lifetime carcinogenic risk posed by contaminants fell within the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  and the HI is below 1 for the current land use. As discussed in **Section 4.6**, the Army chose to actively remediate the site based on the  $1 \times 10^{-6}$  risk level due to a specific request by the NJDEP to remove two AOCs at Site 104 to address New Jersey Non-Residential Direct Contact Soil Cleanup Criteria (NJNRDCSCC) exceedances. Although there were no unacceptable risks to human health at this site, the Army agreed to conduct a limited soil removal, and the basis for this action was in accordance with inter-agency agreements in place at the time.

## **13.2 Remedial Actions: Site 61/104**

### **13.2.1 Remedy Selection**

The ROD for Site 61/104 (PICA-102) was signed by the Army on November 6, 2008 and signed by the USEPA on March 17, 2009. The RAOs as listed in the ROD for Site 61/104 (PICA-102) are as follows:

- Manage soils with calculated risk in the risk range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  following NCP guidance and the Geis Memorandum (1999);
- Maintain current land use (industrial) and current ICs; and,
- Control disturbance and exposure to site soils that could lead to unacceptable human health risks.

Both active (soil excavation) and passive (implementation of LUCs) RAs for soils were selected at this site. The selected RAs included excavations and disposal of impacted soil from two areas of attainment (AA<sub>104SS-1</sub> and AA<sub>104SS-2</sub>) at Site 104. In addition to soil excavation, the selected RA also included LUCs which include the maintenance of existing engineering controls (vegetative cover).

#### 13.2.2 Remedy Implementation

In September of 2008, approximately 55 CY of impacted soil was excavated from Site 104 and disposed of at an approved off-site facility. In addition to backfilling and maintenance of established vegetation, LUCs were implemented at the site in accordance with the approved RD. **Section 4.5.2** discusses LUCs utilized at Picatinny which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants. Remedy implementation included conducting a baseline site inspection and installing four signs along the boundary of the site prohibiting uncontrolled digging. A site map with the LUC area of applicability is included as **Figure 12-1**.

#### 13.2.3 Operation and Maintenance

Annual site inspections were initiated in December 2008 and continue to be completed on an annual basis. The presence of LUCs and the condition of the signs are also verified during the inspection and subsequently certified in Annual LUC Reports. Maintenance to address erosion or other damages to the vegetative soil cover are performed as necessary when identified in the annual site inspection.

### 13.3 Progress Since Last Five-Year Review: Site 61/104

The fourth FYR was the first to include Site 61/104. The protectiveness statement from the previous FYR stated:

*The remedy for Sites 61 and 104 (PICA-102) is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

Annual site inspections have been performed at Site 61/104 and subsequently certified in Annual Land Use Certification Reports. No additional actions have occurred at Site 61/104 since the previous FYR.

No issues or recommendations were identified in the previous FYR report.

### 13.4 Document and Data Review: Site 61/104

#### 13.4.1 Document Review

Relevant and appropriate documents associated with Site 61/104 investigations, remedy development, and operations were reviewed for this fifth FYR report. Site documents can be located at the Picatinny Arsenal website. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2008. Final Remedial Action Work Plan, Sites 61 and 104 (PICA-102). November.

ARCADIS, 2009. Final Remedial Action Report, Sites 61 and 104 (PICA-102). June.

U.S. Army, 2008. Record of Decision, Sites 61 and 104 (PICA-102). November.

#### 13.4.2 Data Review and Evaluation

No new data have been collected since the fourth FYR. Analytical data are not collected as part of the annual site inspections.

### 13.5 Technical Assessment: Site 61/104

#### 13.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

##### 13.5.1.1 Remedial Action Performance

The RAOs for Site 61/104 included management of contaminated soils. The RA at Site 61/104 removed two areas of attainment of approximately 54 CY of contaminated soils. The remaining contaminated soils at the site are addressed through LUCs which have ensured land use remains unchanged and to control disturbances of the site soils which could lead to unacceptable human health risks.

Groundwater contamination at the site is being addressed under the Mid-Valley Groundwater Operable Unit (PICA-204) discussed in **Section 21** of this report.

##### 13.5.1.2 Operations and Maintenance

The LUCs are properly maintained with repairs occurring as issues are identified, primarily replacing damaged signage. At minimum, deficiencies are noted during the annual LUC inspections and documented in the Annual Land Use Certification reports.

##### 13.5.1.3 Opportunities for Optimization

The LUC inspection frequency has been adequate to ensure LUCs at Site 61/104 remain protective of human health and the environment. Therefore, no opportunities for optimization were identified during this FYR.

##### 13.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified during this FYR.

##### 13.5.1.5 Implementation of Land Use Controls and Other Measures

The objective of the LUCs, as stated in the ROD, is to ensure no change in land use occurs, maintain the integrity of engineering controls (vegetative cover), and control excavation at the site. LUCs were implemented for Site 61/104 to ensure that no unacceptable risk to human receptors occurs in the future. LUC certifications have been performed annually since the remedy was implemented.

### 13.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for industrial soil and to the New Jersey NRDCSCC. Based on the comparison of SCLs in the ROD to RSLs and NRDCSCC, current soil concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

The RAOs remain valid as they prevent unintentional exposure to human and ecological receptors of contaminated soils. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment. The Annual LUC inspections have ensured land use remains consistent with what was assumed in the ROD, and no unauthorized disturbances of the soil has occurred.

### 13.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

#### 13.5.3.1 Ecological Risks

No information concerning ecological risks was discovered during the review period that could call the protectiveness of the remedy into question.

#### 13.5.3.2 Natural Disasters

No natural disasters have occurred during the review period that could call the protectiveness of the remedy into question.

#### 13.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information was found during the review period that could call the protectiveness of the remedy into question.

### 13.5.4 Summary of Technical Assessment

The LUCs at Site 61/104 have been inspected annually and remain protective of human health and the environment. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. The RAOs ensure the land use remains industrial and control surface disturbances at the site, thereby restricting potential exposure to contaminated soils. Exposure



assumptions made in the ROD remain valid and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### **13.6 Issues: Site 61/104**

No issues which effect the protectiveness of the remedy were identified for Site 61/104 during this FYR.

### **13.7 Recommendations and Follow-up Actions: Site 61/104**

No recommendations or follow-up actions were identified for Site 61/104 during this FYR.

### **13.8 Protectiveness Statement: Site 61/104**

The remedy at Site 61/104 (PICA-102) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Contaminated soils were excavated and disposed off-site. Established vegetation is being used as an engineering control to limit exposure. Annual LUC inspections have verified that signs remain in place, no unauthorized intrusive activities have occurred, existing surface covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 14.0 Area B Groundwater (PICA-205)

### 14.1 Background: Area B Groundwater

Area B (PICA-205) is approximately 28 acres in size and is located in the southern portion of Picatinny Arsenal (**Figure 14-1**). Area B includes two study sites, Site 20 (PICA-063) and Site 24 (PICA-066). Because Site 20 is completely contained within the boundaries of Site 24, these sites were considered one site (Site 20/24) for scoping and investigation purposes. Historical records and aerial photos taken from the 1950s and 1960s show that Area B (PICA-205) was used as a landfill for sanitary waste, fly ash, ordnance, industrial waste, and sludge from water treatment plants. Site 20 was used for testing pyrotechnics such as flares and signaling devices. Site 20 is currently active and is still used intermittently for the testing of pyrotechnics. Site 24 is currently inactive. Groundwater within Area B (PICA-205) has been separated from the remaining environmental media administratively. Soils at Area B (PICA-205) are addressed in Site 20/24 (PICA-66) which is discussed in **Section 6**.

#### 14.1.1 Land and Resource Use

The PICA-master planning land use designation for the majority of the land within Area B is research, development, and testing. The portions of Area B that are still forested wetlands are designated as wetland on the land use map. The site is used primarily for the testing of pyrotechnic flares, but is also designated as a safe haven parking area and is periodically used for hunting purposes. In addition to the current uses of Area B, the Army has installed a small weather station at Site 20/24. The weather station is situated on a 25-foot by 25-foot concrete pad. The future land use of Area B is anticipated to remain unchanged from current land use activities. Area B will continue to be used for research, development, and testing activities by the Army.

#### 14.1.2 Site Chronology

**Table 14-1: Chronology of Site Events at Area B Groundwater**

Event	Date
Final Feasibility Study	2002
Public comment period on Proposed Plan	2005
Pre-design field work completed	2008
Technical meeting to finalize design components	2008
Baseline Sampling Event	2008
First through Sixth Injection Events	2008-2011
Final Remedial Design	2008
ROD signature	2009
Annual Monitoring and O&M Reports	2008-2015
Fourth Five-Year Review (First FYR for PICA-205)	2011

#### 14.1.3 Basis for Taking Action

A chlorinated solvent plume identified within Area B (PICA-205) Groundwater was the result of historic waste disposal practices. The nature and extent of the groundwater plume has been

investigated and characterized based on several studies performed at the site. The following five COCs in groundwater were identified within the ROD for Area B Groundwater:

- 1,1-DCE
- *cis*-DCE
- PCE
- TCE
- VC

The HHRA (Dames and Moore, 1998) for Area B (PICA-205) Groundwater included groundwater uses for:

- drinking water by Picatinny workers, child/adult residents, and on-site child residents;
- bathing water by on-site child residents; and
- showering water by child/adult residents and on-site child residents.

Groundwater contact through any of these pathways is not expected to occur because of the facility-wide CEA and LUCs that are in place, as discussed in **Section 4.5**. Risk assessments for Area B (PICA-205) Groundwater indicated that VOCs (VC in particular) contributed to an unacceptable risk when evaluated for an ingestion exposure scenario. However, VOCs did not contribute to an unacceptable ecological risk (Dames and Moore, 1998). A remedial action was required to address this unacceptable risk to human health and restore the groundwater to its beneficial use as a drinking water aquifer.

## **14.2 Remedial Actions: Area B Groundwater**

### **14.2.1 Remedy Selection**

The Final ROD for Area B (PICA-205) Groundwater was signed by the USEPA on April 1, 2009. The RAOs as listed in the ROD for Area B (PICA-205) Groundwater are as follows:

- Prevent exposure to Area B groundwater COCs at levels above ARARs
- Protect uncontaminated groundwater for designated uses
- Minimize migration of contaminants to adjacent groundwater and surface water
- Restore contaminated groundwater to comply with its use designation

The selected remedy for Area B (PICA-205) Groundwater is expedited *in-situ* enhanced bioremediation. This remedial technology consists of the introduction of a biostimulant (molasses) via injection to increase the rate which natural microbial degradation of the COCs will occur to attain the RAOs. Components of this remedial approach include:

- Installation of injection wells oriented perpendicular to the groundwater flow and hydraulically downgradient

- Injection of a biostimulant into the groundwater treatment area to achieve a 7-year restoration time
- Periodic groundwater and surface water monitoring to evaluate these media for attenuation of the COCs

Because volatile COCs were identified within groundwater at Area B, vapor intrusion potential was considered. Vapor intrusion is not considered a current issue because there are no buildings in proximity of the Area B plume for potential vapor intrusion, and the selected remedy addresses volatile COCs in groundwater, reducing future potential in the event new buildings are constructed. In addition, only low levels of VC (maximum of 18.6 µg/L) remain at two monitoring locations.

#### 14.2.2 Remedy Implementation

The implementation of the expedited *in-situ* enhanced bioremediation was initiated with the installation of 14 injection wells and nine monitoring wells spanning April to August 2008. The injection well network consisted of installing the injection wells in three injection lines perpendicular to groundwater flow (**Figure 14-2**). In September 2008, groundwater and surface water samples were collected to establish baseline concentrations for VOCs and total organic carbon (TOC). The first injection event was completed in September of 2008 and consisted of a dilute molasses solution. Injection volumes varied from 50 gallons to 1,900 gallons per injection well, with a total of approximately 13,500 gallons of 4% to 6% molasses solution injected.

**Section 4.5.2** discusses LUCs utilized at Picatinny and **Section 4.5.3** discusses the facility-wide CEA restrictions which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants. A site map depicting the LUC area of applicability is included as **Figure 14-1**.

#### 14.2.3 Systems Operations/O&M Requirements

Systems O&M since the previous FYR have included groundwater monitoring, performance monitoring, and surface water monitoring. The monitoring locations, frequency, and parameters are summarized in **Table 14-2** and **Figure 14-2**. Because of the interconnectivity of groundwater and surface water in Area B (PICA-205), samples are collected from the pond and drainage ditches leading from Area B (PICA-205) to Green Pond Brook. Data are evaluated to determine if additional injection events are needed.

A total of six molasses injection events have occurred between 2008 and 2011:

1. September 2008
2. December 2008
3. February 2009
4. November 2009
5. July 2010
6. June 2011

Annual site inspections were initiated in 2008 and are conducted to inspect for indication of inappropriate land use. LUCs inspections and certifications have occurred annually during this review period in accordance with the LUC objectives within the RD.

### 14.3 Progress Since Last Five-Year Review: Area B Groundwater

The protectiveness statement from the fourth FYR was:

*The remedy for Area B (PICA-205) Groundwater is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

There were no issues or recommendations identified during the previous FYR.

Since the fourth FYR, one injection event and five years of monitoring and LUC inspections have been completed. Progress towards meeting RAOs is discussed in **Section 14.4.2**.

### 14.4 Document and Data Review: Area B Groundwater

#### 14.4.1 Document Review

Relevant and appropriate documents associated with the Area B Groundwater remedy selection, implementation, and O&M were reviewed for this fifth FYR. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2008. Final Remedial Design Area B (PICA-205) Groundwater. Picatinny Arsenal, New Jersey. October.

ARCADIS, 2009. Final Interim Remedial Action Completion Report Area B (PICA-205) Groundwater. Picatinny Arsenal, New Jersey. June.

ARCADIS, 2014a. 2013 Annual Monitoring Report Area B (PICA-205) Groundwater. Picatinny Arsenal, New Jersey. May.

ARCADIS, 2014b. 2014 Annual Monitoring Report Area B (PICA-205) Groundwater. Picatinny Arsenal, New Jersey. October.

Dames and Moore, 1998<sup>2</sup>. Phase I Remedial Investigation Report. Prepared for Army Total Environmental Program Support, Delivery Order No. 0005, Draft Final. May.

EA, 2015. 2015 Internal Draft Annual Groundwater Report Area B (PICA-2015). Picatinny Arsenal, New Jersey. December.

U.S. Army, 2009. Record of Decision, Area B Groundwater – Picatinny Arsenal, New Jersey. April.

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<sup>2</sup> Document is referenced but not reviewed.  
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## 14.4.2 Data Review and Evaluation

### 14.4.2.1 Performance Monitoring

Performance monitoring results collected from 2008 through September 2015 indicate strongly reducing conditions have been established as a result of injections, as shown on trend charts provided in the annual reports. Residual TOC and methane remain above baseline levels four years after the last injection event completed in 2011 (**Table 14-3**). Injections have enhanced the naturally reducing conditions present prior to remedy implementation. With the exception of 20/24MW-08, the most distal performance monitoring well, COC concentrations are below SCLs at all other performance monitoring locations. During the September 2015 event, 20/24MW-8 exceeded the SCL for VC at 18.6 µg/L (SCL is 1.0 µg/L). Given the elevated methane at 20/24MW-08 (1.1 mg/L), declining VC at this well, and that COC concentrations have been below SCLs at upgradient well 20/24MW-6 since 2009, COCs at 20/24MW-08 are expected to continue degrading and attenuating.

**Table 14-3: Performance Monitoring Results**

Performance Monitoring Well	TOC above Baseline?	Methane above Baseline?	VOCs < SCLs?		Comments
			During Sept 2015 Event?	How long have VOCs < SCLs?	
Injection Line 1					
20/24MW-17	Yes	Yes	Yes	Mar-11	
20/24MW-16	Yes	Yes	Yes	Jun-14	
Injection Line 2					
20/24MW-15	Yes	Yes	Yes	Sep-12	
20/24IW-03	No	No	Yes	Mar-11	
Injection Line 3					
20/24MW-06	No	No	Yes	Nov-09	See Note 1
20/24MW-06B	Yes	Yes	Yes	Sep-11	
20/24MW-08	Yes	Yes	No	--	See Note 2

**Notes:**

1 – Elevated baseline TOC and methane

2 – VC at 18.6 µg/L, Sept. 2015

TOC = total organic carbon

VC = vinyl chloride

VOC = volatile organic compounds

### 14.4.2.2 Annual Groundwater Monitoring or Periphery Wells

The seven wells monitoring the downgradient and periphery of the plume are listed as annual monitoring wells under the monitoring program (**Table 14-2**). With the exception of 20/24MW-18, results from all other annual locations were below SCLs as of September 2015. Well 20/24MW-18 exceeded the SCL for VC (1.0 µg/L) with a result of 4.6 µg/L during the September 2015 event. During the 2008 baseline results for 20/24MW-18, VC was 5.95 µg/L, and in the previous two years, VC was 1.82 µg/L (2013) and 1.05 µg/L (2014). Unlike many of the IRZ performance monitoring wells, elevated methane and TOC are not present at 20/24MW-18, which may indicate a transition to more aerobic conditions. Because VC can be degraded aerobically or anaerobically, further degradation is likely under either scenario at this location. Surface water location SW-1, located between Injection Line 3 and 20/24MW-18, has not exceeded the SCLs since sampling began in 2008 and there have been

no detections of VC since March 2011. As groundwater treated within the IRZ arrives at 20/24MW-18, residual VC is expected to attenuate.

#### 14.4.2.3 Surface Water

Five surface water locations are monitored annually for COCs and TOC per the monitoring program (**Table 14-2, Figure 14-2**). Locations SW-3 and SW-4 have historically exceeded the SCL for VC with a max concentration of 50.4 µg/L (November 2009) and 15.6 µg/L (March 2012), respectively. Results from all surface water locations were below their SCLs during the most recent event in September 2015. Trend charts provided in the annual report indicate surface water quality has improved since remedy implementation.

#### 14.4.2.4 Progress Towards RAOs

The 2009 ROD states that compliance with RAOs is expected within 7 years of remedy implementation (or September 2015). While significant progress towards achieving RAOs has been made, monitoring will need to extend a few years beyond 2015. The monitoring program could be reviewed for optimization opportunities, including locations, analytes, and frequency. A decision tree or flow chart may be helpful to document the rationale for removing wells from the monitoring program.

### 14.5 Technical Assessment: Area B Groundwater

#### 14.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

##### 14.5.1.1 Remedial Action Performance

Significant progress has been made towards achieving RAOs. The selected remedy has been effective in treating COCs, and in six of the seven annual monitoring locations, COCs are below SCLs as of September 2015. Remaining exceedances for VC (4.6 µg/L at 20/24MW-18 and 18.6 µg/L at 20/24MW-08) are expected to continue declining. Surface water quality has also improved as a result of remedy implementation.

##### 14.5.1.2 Operations and Maintenance

While the ROD's estimated seven year timeframe to meet RAOs was not achieved, additional injection events are most likely not necessary. A few years of additional monitoring will be necessary to meet RAOs. Extension of the current monitoring program will be completed in accordance with the RD (and recommendations from final annual monitoring reports).

##### 14.5.1.3 Opportunities for Optimization

Given that only two locations currently exceed the SCL for VC, and that the monitoring program has been largely unaltered since 2008 (i.e., trends have been established), the performance and annual monitoring program should be reviewed for optimization opportunities which may include reductions in locations, analytes, and frequencies.

#### 14.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified.

#### 14.5.1.5 Implementation of Land Use Controls and Other Measures

LUCs inspections and certifications have occurred annually since remedy implementation in 2008. The LUC objectives established in the RD are being tracked within annual LUC and NFA monitoring reports in accordance with LUC objectives, and no issues or corrective actions have been noted. The facility-wide CEA restricts groundwater use at the site, thereby restricting potential exposure to contaminants.

#### 14.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for tapwater and the New Jersey GWQC. Based on the comparison of SCLs in the ROD to RSLs and GWQC, current groundwater concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

The RAOs remain valid as they prevent exposure to and minimize migration of groundwater contaminants. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment until the contaminated groundwater is restored to levels below chemical-specific ARARs.

#### 14.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

##### 14.5.3.1 Ecological Risks

No new ecological risks have been identified that could call the effectiveness of the remedy into question.

##### 14.5.3.2 Natural Disasters

No natural disasters have occurred during the review period that could call into question the protectiveness of the remedy.



#### 14.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other new information has been found that could call the protectiveness of the remedy into question.

#### 14.5.4 Summary of Technical Assessment

The remedy has been implemented and is operating as intended by the ROD and RD. Groundwater and surface water quality have significantly improved as a result of injections and MNA. Performance and annual groundwater and surface water monitoring have been completed, consistent with the RD. Annual LUC inspections and maintenance of the facility-wide CEA restricting groundwater use ensure LUCs remain effective at restricting potential exposure to contaminated groundwater and surface water. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### 14.6 Issues: Area B Groundwater

No issues have been identified that affect the current and/or future protectiveness.

### 14.7 Recommendations and Follow-up Actions: Area B Groundwater

No recommendations affecting the current or future protectiveness were identified.

#### 14.7.1 Other Findings

As discussed in **Section 14.5.1.3**, opportunities were identified that may support optimization of the monitoring program. A few years of additional monitoring, beyond the 7 years estimated in the ROD, will be needed to meet RAOs.

### 14.8 Protectiveness Statement: Area B Groundwater

The remedy for Area B (PICA-205) Groundwater is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Historical injection of carbon solution (*in-situ* enhanced bioremediation) has resulted in significant progress towards meeting RAOs. Performance and annual groundwater and surface water monitoring have been completed, consistent with the RD. The facility-wide CEA restricts access to and use of groundwater at Picatinny. Annual LUC inspections ensure the integrity of monitoring wells, injection wells, and signs are maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 15.0 Site 31/101 (PICA-072) – Former Defense Reutilization and Marketing Office

### 15.1 Background: Site 31/101

Site 31/101 (PICA-072) – Former Defense Reutilization and Marketing Office (DRMO) is located in Area G adjacent to GPB. The former DRMO yard, is located along Eleventh Avenue, south of the intersection of Sixth Street and Reilly Road (**Figure 15-1**). The site is a fenced-in area that currently contains five buildings. While operational, all five of these buildings were associated with the DRMO operation. Currently all five of the buildings are in relatively good condition, and some of the buildings are used for inert storage. Much of the area within the fence line is paved.

Part of the site includes Site 101, located immediately north of the Former DRMO area, which encompasses former Building 311 (Gas Station), Building 319 (currently known as Safety, Surety, and Environmental Office), and the paved area to the south of these buildings (**Figure 15-1**). Former Building 311 and Building 319 are located between Eleventh Avenue and GPB, in the northeastern portion of Area G. Building 311 was built in 1941 and was used as a gasoline station until December 1991. The gasoline station consisted of several gasoline pumps and a computer-operated dispensing unit. The gasoline pumps were removed from service in June 1991.

#### 15.1.1 Site Chronology

**Table 15-1: Site 31/101**

Event	Date
Final Feasibility Study	2005
Record of Decision	2009
Remedy Construction / Implementation	2009
Annual Inspections and LUC Certifications	2009-2015
Final Remedial Action Report	2010
Fourth Five-Year Review (First Five-Year Review at the site)	2011

#### 15.1.2 Basis for Taking Action

COCs were identified for the site surface and subsurface soil based on contribution to the majority of site-specific human health risk or exceedance of NJNRDCSCC. The 19 surface soil COCs, as identified in the ROD, include:

- PCBs (Aroclor-1248, Aroclor-1254, Aroclor-1260)
- antimony (surface soil only)
- arsenic
- cadmium (subsurface soil only)
- copper
- lead
- mercury (surface soil only)
- thallium (surface soil only)
- zinc

- benz(a)anthracene
- benzo(a)pyrene
- benzo(b)fluoranthene
- benzo(k)fluoranthene
- chrysene (surface soil only)
- dibenzo(a,h)anthracene
- indeno(1,2,3-cd)pyrene
- pyrene (surface soil only)
- 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (surface soil only)
- 2,4-dinitrotoluene (subsurface soil only)

The HHRA for the site was conducted during the 1998 Phase I RA. Because a significant amount of new data was collected at the site after the Phase I RI, the baseline HHRA was updated, and the results of this HHRA were reported in the Final RI Report for Sites 3, 31, 192, and 199 in 2004. This HHRA included exposure scenarios for the current/future industrial research workers, future construction/excavation workers, and current/future on-site youth visitor. The results of the HHRA indicated that under the current and hypothetical exposure scenarios, the excess lifetime carcinogenic risk posed by contaminants exceeded the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ , and the HI is above 1 for the current land use. A remedial action was required to mitigate this unacceptable risk.

An ERA was not performed specifically at the site due to limited habitat and a lack of samples collected during the Phase I RI; therefore a portion of the site was subsequently included in the assessment area for an ERA performed at the adjacent Former Gas Station (Site 101). Results of the ERA are summarized in the ROD for the site.

## **15.2 Remedial Actions: Site 31/101**

### **15.2.1 Remedy Selection**

The ROD authorizing this RA was signed by the U.S. Army on December 5, 2008 and by the USEPA on June 9, 2009. The RAOs, as developed in the ROD, are as follows:

- Prevent exposure to surface and subsurface soils which results in unacceptable risk to human and ecological receptors
- Prevent migration of COCs above SCLs in site soil to Green Pond Brook sediment
- Prevent impact to groundwater by all site COCs above SCLs

The selected RAs included:

- Excavation and off-site disposal of soil with PCB concentrations greater than 160 mg/kg
- Excavation and off-site disposal of lead-contaminated soil adjacent to GPB
- Installation of an asphalt cap
- Implementation of LUCs

### 15.2.2 Remedy Implementation

In August 2008, pre-excavation confirmatory and waste characterization sampling activities were conducted at the Former DRMO Yard and Former Gas Station (PICA-072, Site 31). This sampling event was halted due to the discovery of suspected Improved Conventional Munitions (ICMs) disposed of on the surface at the site. Approximately half an acre within the six-acre Former DRMO Yard was designated as an ICM Site due to the discovery of 192 ICMs scattered about the surface of the site. Starting in June 2009, the surface and near surface ICMs, conventional munitions and munitions debris were removed and disposed of by detonation as part of a Time Critical Removal Action under the Army's Military Munitions Response Program. All items were determined to be inert practice rounds.

Upon removal of the ICMs, remedial activities were conducted at Site 31/101 (PICA-072) and included the following actions:

- 852 CY of hazardous soil was excavated and disposed at an off-site facility
- 3,529 CY of soil, spanning a 41,856 SF area, was excavated and consolidated on site
- Approximately 4,600 CY of clean soil was imported to the site and used to backfill the excavations
- A soil cover (31,683 sf) was constructed in addition to an asphalt cap (19,713 sf)
- Repair or improvement of 6,569 sf of existing asphalt

In addition to these remedial actions, LUCs were implemented at the site in accordance with the approved RD. **Section 4.5.2** discusses LUCs utilized at Picatinny which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants. Remedy implementation included conducting a baseline site inspection and installing five signs along the boundary of the site prohibiting uncontrolled digging. A site map with the LUC area of applicability is included as **Figure 15-1**.

### 15.2.3 Operation and Maintenance

Annual site inspections were initiated in December 2009 and continue to be completed on an annual basis. The presence of LUCs and the condition of the engineering controls (soil cover, asphalt caps, Building 314D) and signs are also verified during the inspection and subsequently certified in Annual Land Use Certification Reports.

## 15.3 Progress Since Last Five-Year Review: Site 31/101

The fourth FYR was the first FYR at Picatinny Arsenal to include Site 31/101 (PICA-072). The protectiveness statement from the fourth FYR stated:

*The remedy for Site 31/101 (PICA-72) is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

Annual site inspections have been performed at the Former DRMO and subsequently certified in Annual Land Use Certification Reports. No additional actions have occurred at the site since the previous FYR.

No issues or recommendations were identified in the previous FYR report.

#### **15.4 Document and Data Review: Site 31/101**

##### **15.4.1 Document Review**

Relevant and appropriate documents associated with Site 31/101 investigations, remedy development, and operations were reviewed for this fifth FYR. Site documents can be located at the Picatinny Arsenal website. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2009. Final Remedial Action Work Plan, Sites 31 and 101 (PICA-072), Former DRMO Yard and Gas Station. Picatinny Arsenal, New Jersey. June.

ARCADIS, 2010. Final Remedial Action Report, Site 31/101 (PICA-072), Former DRMO Yard and Former Gas Station. Picatinny Arsenal, New Jersey. October.

ARCADIS, 2011. Final Mitigation Plan, Former DRMO Yard, ICM Site. Picatinny Arsenal, New Jersey. February.

U.S. Army, 2008. Record of Decision, Site 31/101 (PICA-072) Soil. November.

##### **15.4.2 Data Review and Evaluation**

Chemical data is not collected as part of the remedy at Site 31/101 (PICA-072). Annual LUC inspections are conducted to document the condition of the sites and to verify no changes in land use or intrusive activities have occurred. Site specific LUCs are in effect and are protective of human health and the environment, as documented in the 2011, 2012, 2013, and 2014 annual LUC inspection certification reports.

#### **15.5 Technical Assessment: Site 31/101**

##### **15.5.1 Question A**

*Is the remedy functioning as intended by the decision documents?*

Yes.

##### **15.5.1.1 Remedial Action Performance**

The Remedial Action Report (RAR) documented the complete removal and/or consolidation of impacted soils with COC concentrations above the SCLs. The vegetative cover, asphalt cover, and Building 314D remain in place and eliminate exposure to contaminated subsurface soils.

#### 15.5.1.2 Operations and Maintenance

The LUCs are properly maintained with repairs occurring as issues are identified. At minimum, deficiencies are noted during the annual LUC inspections and documented in the Annual Land Use Certification reports.

#### 15.5.1.3 Opportunities for Optimization

The LUC inspection frequency has been adequate to ensure LUCs at the site remain protective of human health and the environment. Therefore, no opportunities for optimization were identified during this FYR.

#### 15.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified during this FYR.

#### 15.5.1.5 Implementation of Land Use Controls and Other Measures

Engineering controls such as the vegetative cover, asphalt cover, and Building 314D remain in place and eliminate exposure to contaminated subsurface soils. Residential use of the site is prohibited, and the site land use continues to be industrial research. Both the controls and land use are inspected annually, and the findings are documented in the Annual Land Use Certification Report.

### 15.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for industrial soil and the New Jersey NRDCSCC. Based on the comparison of SCLs in the ROD to RSLs and NRDCSCC, current soil concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

The RAOs remain valid as they prevent exposure to human and ecological receptors of contaminated soils and reduce off-site transport of contaminants via erosion or groundwater migration from surface infiltration. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment.

### 15.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

#### 15.5.3.1 Ecological Risks

No new information on ecological risks has been developed during this review period that might call into question the protectiveness of the remedy.

#### 15.5.3.2 Natural Disasters

No natural disasters have occurred that might call the effectiveness of the remedy into question.

#### 15.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other new information has been found that could call the effectiveness of the remedy into question.

#### 15.5.4 Summary of Technical Assessment

The LUCs at the Former DRMO Yard and Former Gas Station have been inspected annually and remain protective of human health and the environment. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. The selected remedy and RAOs restrict potential exposure to contaminated soils, minimize surface runoff to GPB, and minimize infiltration of surface water to contaminated soils. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### 15.6 Issues: Site 31/101

No issues which effect the protectiveness of the remedy were identified for Site 31/101 during this FYR.

### 15.7 Recommendations and Follow-up Actions: Site 31/101

No recommendations or follow-up actions were identified for Site 31/101 during this FYR.

### 15.8 Protectiveness Statement: Site 31/101

The remedy at Site 31/101 (PICA-072) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Contaminated soils were excavated and either disposed off-site or consolidated onside beneath a cover. A soil and asphalt cover were installed as an engineering control to limit exposure. Annual LUC inspections have verified that signs remain in place, no unauthorized intrusive activities have occurred, the vegetative and asphalt covers have been maintained, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 16.0 Area C (PICA-206) Groundwater

### 16.1 Background: Area C Groundwater

Area C is approximately 126 acres in size and is located in the southwestern corner of Picatinny Arsenal near the ridge that forms the eastern boundary of the arsenal. **Figures 16-1** and **16-2** depict the location and site layout of Area C (PICA-206) Groundwater. The area is bounded by Green Pond Brook and Area B to the northwest, Route 15 to the southwest, and the steep hillside running adjacent to Parker Road to the east. Area C is comprised of five sites:

- Site 19 (Pyrotechnic Demonstration Area), PICA-020
- Site 25 (Sanitary Landfill), PICA-067
- Site 26 (Dredge Pile), PICA-068
- Site 163 (Baseball Fields), PICA-092
- Site 180 (Waste Burial Area), PICA-093

Two additional sites, Site 34 (Former Lower Burning Ground) and a Former Skeet Range, have also been identified in this area, but are being investigated or monitored separately and are not considered part of Area C. Site 34 (Former Lower Burning Ground), discussed in **Section 19**, has its own groundwater monitoring plan and investigations are currently ongoing at the Former Skeet Range. The predominant land use throughout Area C is industrial with small areas that are intermittently used for recreational purposes (hunting and softball). According to the Vision Plan, the future land uses within Area C will continue to be for industrial and intermittent recreational activities.

There was concern about groundwater contamination in Area C due to historic activities that have been conducted within the area, such as land filling (Site 25), dumping (Site 180), and testing (Site 19). Further, because the southern boundary is the point where some Picatinny Arsenal groundwater flows off post, the Army wanted to ensure that human health and the environment would be protected from unacceptable risk. The Army as the lead agency has investigated these concerns and worked with the USEPA and NJDEP to ensure the investigation was complete.

The Phase I RI Report concluded that there were only limited exceedances of VOCs and dioxins/furans in groundwater in Area C. Detections of explosive compounds appeared to be related to activities at the Burning Ground (Site 34) and the pyrotechnic area (Site 19). Exceedances of lead and arsenic were widespread throughout the area with no specific identifiable source.

In February 2000 the Army, the NJDEP and the USEPA agreed that additional sampling would be conducted to confirm that the extent of detections in Area C groundwater was still consistent with the results reported in the Phase I RI report. Two rounds of groundwater sampling were conducted in the winter of 2001 and the winter of 2002 at targeted Area C wells and the southern boundary wells. Area C and southern boundary monitoring wells were targeted to locations with the most significant detections encountered during the Phase I RI. Results generally confirmed the Phase I RI results. There were limited, sporadic VOC detections and widespread arsenic and lead exceedances. However, the



dioxin/furan concentrations detected during the Phase I sampling were not repeated in the 2001 sampling.

Monitoring of southern boundary groundwater was conducted for 13 rounds of sampling from 2002 to 2008. A limited number of exceedances were observed during this period, demonstrating that the groundwater contamination observed within Area C is isolated and of limited extent. During this monitoring period, several LOCs, which are based on current regulatory criteria, decreased such as VC, arsenic, beryllium and lead. As a result, additional wells have been identified with LOC exceedances for these compounds. However, the number of exceedances has decreased over time, indicating a downward trend in the concentrations and suggesting that the contamination is attenuating.

Lead has been detected in areas along the southern boundary; however, continued monitoring has shown that the levels are decreasing.

Arsenic has been detected in multiple samples in the vicinity of Site 25 at concentrations marginally above LOCs; however, the area in which arsenic is present in exceedance of LOCs is relatively limited in extent, and arsenic has only been detected in two southern boundary monitoring wells (SB2-1A and SB2-2) above the LOC of 3.0 µg/L since 2005.

Overall, detections of constituents above criteria in groundwater have either been sporadic and isolated at low concentrations (such as Cyclotrimethylenetrinitramine [RDX], VOCs and dioxins/furans), potentially related to local background geology (such as the naturally-occurring metals iron, manganese, and aluminum), or not related to site activities occurring at Picatinny. The Leithsville Dolomite, which underlies Area C, contains numerous accessory minerals including arsenopyrite and galena which may be contributing to metals concentrations (including lead and arsenic) in groundwater.

#### 16.1.1 Land and Resource Use

Area C is designated for industrial use and intermittent recreational use (i.e., hunting and softball), which means no other uses such as residential or agricultural are permitted. No use of fenced portions of the area, such as the Burning Ground (Site 34) for hunting, is permitted. Hunters are permitted to hunt on other portions of Area C and to traverse the area for the purpose of using other designated hunting locations.

#### 16.1.2 Site Chronology

**Table 16-1: Chronology of Site Events at Area C Groundwater**

Event	Date
Site Investigations	1981-2007
Shaw, Area C Groundwater Feasibility Study	2005
Area C Record of Decision	2009
Shaw, Long Term Monitoring Plan and Land Use Controls Remedial Design for Area C	2009
Weston/Arcadis, Area C Groundwater Long Term Monitoring Report Round A-H	2010-2014
Fourth Five-Year Review (first for Area C)	2011

### 16.1.3 Basis for Taking Action

Numerous environmental investigations and extensive groundwater monitoring have been conducted within Area C and along the southern boundary of the facility to evaluate whether past activities may have affected the groundwater in the area. Results of the prior investigations were used during the FS phase to develop RAOs and identify COCs. COCs identified at Area C (PICA-206) Groundwater include arsenic and lead.

The HHRA (Dames and Moore, 1998) for Area C (PICA-206) Groundwater included groundwater uses for: drinking water by Picatinny workers, child/adult residents, and on-site child residents; and showering water by child/adult residents and on-site child residents. Groundwater contact through any of these pathways is not expected to occur because of the facility-wide CEA and LUCs that are in place. Risk assessments for Area C (PICA-206) Groundwater identified a cancer risk above the USEPA's target risk range of  $1 \times 10^{-6}$  to  $1 \times 10^{-4}$  for potential future exposure scenarios. Unacceptable human health risks are only associated with Area C groundwater exposure via the ingestion and inhalation pathways. The non-cancer HI exceeded the target HI of 1 for the exposure scenarios. A remedial action was required to address this unacceptable risk to human health and restore the groundwater to its beneficial use as a drinking water aquifer.

COCs were identified for Area C groundwater based on exceedance of groundwater standards, risk and hazard contributors in the HHRA, and contaminant distribution indicative of a contaminant plume. Inorganic contaminants exhibiting random distribution or that likely were attributable to background conditions or site geology were removed from COC consideration. Organic contaminants that were sporadically detected and not confirmed in adjacent or subsequent samples were also eliminated via this criterion. For two metals, arsenic and lead, concentrations were detected at levels greater than promulgated groundwater comparison criteria, were not sporadic, and were confirmed at multiple locations during multiple rounds of sampling. Arsenic was a significant driver of unacceptable risk and hazard in both aquifers and all exposure scenarios lead has exhibited persistent detections above promulgated groundwater criteria. Thus, arsenic and lead were considered COCs.

The Area C Groundwater (PICA-206) study area does not address other media (i.e., soil, surface water, or sediment). Area C groundwater from the unconfined aquifer ultimately discharges into Green Pond Brook. As both human health and ecological risks associated with water in Green Pond Brook are addressed separately in the Green Pond Brook ROD, ecological risk was not evaluated for Area C groundwater.

## 16.2 Remedial Actions: Area C Groundwater

### 16.2.1 Remedy Selection

The Final ROD for Area C (PICA-206) Groundwater was signed by the USEPA on September 1, 2009. RAOs for Area C Groundwater were developed pursuant to exceedances of chemical specific ARARs (New Jersey Groundwater Criteria/PQLs) and unacceptable risk identified for reasonably anticipated future use.

The RAOs for Area C Groundwater are as follows:

- Prevent exposure to contaminated groundwater

- Protect uncontaminated groundwater for designated uses
- Attain SCLs in Area C groundwater

The remedial alternative selected to protect human health for Area C Groundwater consists of the following components:

- LUCs to ensure protectiveness, including land use and access restrictions, public education, and emergency provisions throughout the entire duration of the RA.
- Use of the existing facility-wide CEA/Well Restriction Area. The CEA mandates that any proposed groundwater use within the well restriction area will require review and approval to implement modifications that would be protective of any impacts from identified contaminants for the duration of the CEA.
- Implementation of groundwater LTM to ensure the effectiveness of the RA.
- Performance of FYRs in accordance with CERCLA and the NCP.
- Development of a remediation exit strategy to determine when monitoring efforts should be reevaluated or discontinued.

The objective of the actions described in this ROD is to ensure site conditions are protective of human health and the environment through LTM. **Section 4.5.2** discusses LUCs utilized at Picatinny and **Section 4.5.3** discusses the facility-wide CEA restrictions which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants.

#### 16.2.2 Remedy Implementation

The LTM sampling program was implemented in January and February 2010. Groundwater samples were collected from the 32 monitoring wells. A well-specific analyte list was developed for each well and is presented in the RD. Field parameters (temperature, pH, oxidation-reduction potential [ORP], specific conductance, dissolved oxygen [DO], and turbidity) were recorded during sampling.

#### 16.2.3 Operation and Maintenance

In accordance with the RD, groundwater samples were collected semi-annually, for two years. In order to evaluate temporal changes or seasonal fluctuations in water level and groundwater flow regimes, the first four semi-annual sampling events were conducted seasonally. The scope of the LTM initially consisted of sampling 32 existing wells associated with Area C including the 16 southern boundary wells. **Figure 16-3** shows the locations and designations of the monitoring wells and **Table 16-3**. The sampling frequency is determined by the exit strategy. As of the summer 2014 sampling event, a total of 26 wells were sampled as part of the LTM. The two primary constituents identified in the FS as COCs were arsenic and lead. These constituents have historically been detected above the groundwater ARARs. The current sampling parameters are limited to arsenic, lead and VC. In addition to the chemical analyses, groundwater also was sampled for field parameters, including pH, turbidity, conductivity, temperature, ORP, and water level. The first three parameters are required because they

can have a large impact on detectable metal concentrations and the exit strategy calls for evaluations of those parameters in the case of metal COCs.

Future groundwater use that could result in unacceptable risks to human health is controlled through the CEA and LUCs. The CEA is updated every two years and the LUCs are certified annually.

### **16.3 Progress Since Last Five-Year Review: Area C Groundwater**

The fourth FYR was the first FYR for Area C (PICA-206) Groundwater. The protectiveness statement from the fourth FYR was:

*The remedy for Area C (PICA-206) Groundwater is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

No issues or recommendations were identified in the previous FYR. Since the last FYR, seasonal groundwater monitoring has been conducted at least annually. A total of nine sampling events have occurred since the implementation of the RD in 2010. The number of wells included in the LTM has been reduced. Through 2014, five Area C monitoring wells, MW-16, MW25-7, C1-A, DM25-3, and LF-2 were decommissioned and one well, MW 3548-3, was removed from the sampling program as it was assumed to have been destroyed (USACE, 2014c). After an effort to locate well MW 3548-3 was unsuccessful, two downgradient wells constructed in the same aquifer, B1181MW-1 and B1181 MW-2, were sampled twice. Sampling results from these wells in addition to historical results from 3548-3 were used in statistical analyses in the fall of 2013. The results of the statistical analysis allowed well 3548-3 to be removed from the LTM program in accordance with the RD. Annual inspections and LUC certification has been completed. No additional actions have occurred at Area C since the previous FYR.

### **16.4 Document and Data Review: Area C Groundwater**

#### **16.4.1 Document Review**

Relevant and appropriate documents associated with the Area C (PICA-206) Groundwater investigations, remedy development, and operations were reviewed for this fifth FYR Report. Key documents reviewed included:

Shaw, 2009. Long Term Monitoring Plan and Land Use Control Remedial Design for Area C Groundwater, Picatinny Arsenal, New Jersey, November.

ARCADIS, 2014. Final Biennial Certification Monitoring Report for a Groundwater Exception Area (CEA), U.S. Army Garrison, Picatinny Arsenal, New Jersey, September.

USACE, 2012a. Area C Groundwater Long Term Monitoring Report Round D Statistical Evaluation, Picatinny Arsenal, New Jersey, May .

USACE, 2012b. Draft Final Area C Groundwater Long-Term Monitoring Report Round E Statistical Evaluation, Picatinny Arsenal, New Jersey, November.

USACE, 2013. Draft Final Area C Groundwater Long-Term Monitoring Report Round F Statistical Evaluation, Picatinny Arsenal, New Jersey, August.

USACE, 2014a. Draft Final Area C Groundwater Long-Term Monitoring Report Round G Statistical Evaluation, Picatinny Arsenal, New Jersey, March.

USACE, 2014b. Draft Final Area C Groundwater Long-Term Monitoring Report Round H Statistical Evaluation, Picatinny Arsenal, New Jersey, May.

USACE, 2014c. Draft Final Area C Groundwater Long-Term Monitoring Report Round I Statistical Evaluation, Picatinny Arsenal, New Jersey, October.

USEPA, 2009. Picatinny Arsenal Area C Groundwater Record of Decision September.

#### 16.4.2 Data Review and Evaluation

An exit strategy was developed to specify the constituent levels at which the frequency of groundwater monitoring can be altered or discontinued. The exit strategy includes a decision logic diagram for termination of the RA as presented in **Figure 16-3**. According to the exit strategy outlined in the RD, a statistical evaluation was to be conducted after the first two years using the data collected semiannually and then again during the FYR. However, the approved LTM RD included an exit strategy flow chart that accelerated the statistical evaluation as part of every subsequent LTM event. To date, five statistical evaluations have been conducted. The statistical evaluations conducted in the annual reports referenced above have provided the rationale to reduce the number of analytes included in the LTM.

Based on the LTM flow chart included in the RD and annual reports, and the sampling results collected during this review period, the monitoring program has been reduced to 26 sampling locations. The sampling program has been reduced to three analytes (VC, arsenic and lead), at most but not all of the 26 monitoring wells, in addition to field parameters. All of the wells are monitored on at least an annual basis. **Table 16-2** shows the recommended LTM sample frequency and analyte list from the 2014 Monitoring report (ARCADIS, 2014).

As of the 2014 sampling round, arsenic, lead and VC remain above SCLs. VC was detected in two wells (DM19-1 and DM 25-2). The detection in DM25-2 was below the LOC and DM19-1 had detections of 16 µg/L and 15 µg/L in 2014 which is above the trigger level of 6.6 µg/L. Arsenic was detected in 19 wells, only 7 of those detections were above the LOC, with the maximum concentration detected at 87 µg/L. Lead was detected in 5 wells at a maximum concentration of 86 µg/L with 4 wells exceeding the LOC.

#### **Basis for Arsenic and Lead Occurrence:**

A number of field parameters can significantly impact the solubility of certain metals, and therefore, metals concentrations in groundwater. Therefore, as part of the exit strategy for arsenic and lead, an evaluation of groundwater quality parameters was conducted. The main factors affecting arsenic concentrations in groundwater include desorption and dissolution. Desorption and dissolution can be affected by an influx of competing ions, such as phosphate ( $\text{PO}_4^{3-}$ ) or carbonate ( $\text{CO}_3^{2-}$ ), or through changes in the groundwater chemistry, mainly pH and redox potential, that cause the sorbent material to

no longer be stable. A strong correlation between pH and arsenic concentrations in groundwater has been identified, with concentrations typically increasing as the pH increases. Due to adsorption to soil particles, concentrations of arsenic in groundwater typically increase with increased turbidity. Review of the main factors affecting lead concentrations in groundwater are adsorption at the solid-water interface, precipitation, and complexation with organic matter. Under alkaline conditions, aqueous concentrations are limited by the precipitation of hydroxide and carbonate mineral phases and adsorption to negatively charged surfaces. Therefore, lead solubility should increase with decreasing pH (USEPA 2007). Due to the adsorption of lead to soil particles, concentrations of lead in groundwater under circumneutral to alkaline pH are often associated with suspended particles and, therefore, are correlated with turbidity (USACE, 2014b).

An evaluation of field parameter values and anion concentrations versus arsenic and lead concentrations was conducted for the nine rounds of LTM sampling data to determine if the concentrations appear to be affected by these factors. Overall, the data do indicate that many of the highest arsenic concentrations are correlated with low DO and ORP (and in some cases turbidity), indicating that iron-reducing conditions may be contributing to arsenic in some areas. Lead concentrations appear to be weakly correlated with turbidity, however the filtration analysis does confirm a suspended-solid association for lead suggesting that lead-containing colloids may be present even under low apparent turbidity (USACE, 2014c).

Both lead and arsenic are the primary COCs. Contamination is sporadic, there is no identified source area, and there is no known usage in the area. There is however, arsenopyrite and galena in the bedrock, and arsenite in mines, and their associated tailings in the area. In Morris County alone there are well over 200 historic and active iron mines listed. One of the oldest iron mines in New Jersey, Mt. Hope magnetite mine started production in 1710 and is located within a mile of Picatinny. There are five abandoned mines located adjacent to, or on the Picatinny property. The magnetite mined in this area includes arsenites (oxides). Sulfides (arsenopyrite and galena) are found in association with the Green Pond and Davenport ore bodies. Groundwater contamination from arsenic arises from sources of arsenopyrite, base metal sulfides, arsenic-rich pyrite, and iron oxyhydroxide, all of which are common in the area. The mechanisms in which arsenic is released are varied but include oxidation of arsenic-bearing sulfides, desorption from oxides and hydroxides, and leaching from sulfides. In Area C there is no known sources for the arsenic and lead contamination, the concentrations and occurrence is both low level and sporadic, there are arsenic and lead sources in the bedrock and associated with mines in the immediate area, and there is a correlation between reducing conditions and increased arsenic concentrations. Other metals detected, such as iron, manganese, aluminum, and sodium, have been eliminated as COCs due to being naturally occurring and associated with the local geology, or are not known to be related to PTA activities.

## **16.5 Technical Assessment: Area C Groundwater**

### **16.5.1 Question A**

*Is the remedy functioning as intended by the decision documents?*

Yes.

#### 16.5.1.1 Remedial Action Performance

The LTM and approved exit strategy have been successful in reducing the number of wells and analytes in the LTM program. The upgradient wells confirm that no new contamination is migrating into Area C Groundwater, and the 16 sentry wells confirm that contamination has not migrated off-site.

#### 16.5.1.2 Operations and Maintenance

The LTM program has been conducted in accordance with the LTM program outlined in the RD and recommendations stemming from statistical analyses and decision flow charts. Future monitoring will be completed in accordance with the RD (and recommendations from annual monitoring reports). The Army has also agreed that there will be annual sampling for the 16 southern boundaries for VOCs, metals and explosive compounds. This is considered to better ensure contaminants are not leaving the boundary of the Picatinny.

#### 16.5.1.3 Opportunities for Optimization

There is a potential opportunity to improve the overall remedial effort at Area C, and site-wide, which could significantly reduce the time and funding necessary to achieve the RGs in Area C. It is very likely that two of the COCs, arsenic and lead, are naturally occurring. It is recommended that a summary of these low level detections of arsenic and lead at Area C and elsewhere on Picatinny be provided in the form of a technical memorandum, so these data can be compared to regional concentrations in groundwater. Results of this comparison may determine if the arsenic and lead contamination at Area C and potentially other Picatinny sites is naturally occurring.

#### 16.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified.

#### 16.5.1.5 Implementation of Land Use Controls and Other Measures

LUC inspections and certifications have occurred annually during this FYR period. The LUC objectives established in the RD are being tracked within annual LUC and NFA monitoring reports in accordance with LUC objectives, and no issues or corrective actions have been noted.

### 16.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for tapwater and the New Jersey GWQC. Based on the comparison of SCLs in the ROD to RSLs and the GWQC, current groundwater concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This

evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

Because groundwater at Area C includes detections of VC, the potential for VI was assessed. However, VI is not considered a current issue because there are no buildings in the vicinity of the two wells with detections of VC (maximum detection of 16 µg/L at DM19-1). In the event land use changes or buildings are constructed, then the potential for VI will be reassessed.

The RAOs are to prevent human exposure to contaminated groundwater at the site. The RAOs remain valid as they do not allow for unacceptable risk to human health.

#### 16.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

##### 16.5.3.1 Ecological Risks

No new information on ecological risks has been found that could call into question the protectiveness of the remedy.

##### 16.5.3.2 Natural Disasters

No natural disasters have occurred that call into question the protectiveness of the remedy.

##### 16.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No new information has been found that could call into question the protectiveness of the remedy.

#### 16.5.4 Summary of Technical Assessment

The remedy has been implemented and is operating as intended by the ROD and RD. The LTM program has been conducted in accordance with the LTM program and exit strategy outlined in the RD. The monitoring program has been reduced from 32 to 26 sampling locations, and in most wells, analytes reduced to three COCs (VC, arsenic and lead). To date no contaminants have exceeded the trigger action for a more aggressive remedial approach. Annual LUC inspections and maintenance of the facility-wide CEA restricting groundwater use ensure LUCs remain effective at restricting potential exposure to contaminated groundwater. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

#### 16.6 Issues: Area C Groundwater

No issues were identified affecting the current or future protectiveness of the Area C (PICA-206) Groundwater remedy.



#### **16.7 Recommendations and Follow-up Actions: Area C Groundwater**

No recommendations were identified affecting the current or future protectiveness of the Area C (PICA-206) Groundwater remedy.

However there is an opportunity to improve the overall remedial effort at Area C, and site-wide, which could significantly reduce the time and funding necessary to achieve the RGs. Because arsenic and lead are naturally occurring in bedrock and the immediate area, it is recommended that a summary of these low level detections of arsenic and lead at Area C and elsewhere on Picatinny be provided in the form of a technical memorandum. These data could be compared to regional concentrations in groundwater. Results of this comparison may determine if the arsenic and lead contamination at Area C and potentially other Picatinny sites is naturally occurring.

#### **16.8 Protectiveness Statement: Area C Groundwater**

The remedy for Area C (PICA-206) Groundwater is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. The LTM program has been conducted in accordance with the LTM program and exit strategy outlined in the RD. The monitoring program has been reduced from 32 to 26 sampling locations, and in most wells, analytes reduced to three COCs (VC, arsenic and lead). To date no contaminants have exceeded the trigger action for a more aggressive remedial approach. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring systems and signs has been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## **17.0 Group 3 Sites Groundwater (PICA-008, Site 2)**

### **17.1 Background: Group 3 Sites Groundwater**

Group 3 Sites (PICA-008) is located along the unnamed ridge that trends from the northeast to the southwest along the southeast side of the installation (**Figure 17-1**). The area is transected by a small valley that trends from northwest to southeast, perpendicular to the direction of the axis of the ridge on which it is located. Elevations within this valley range from 800 to 900 ft above mean sea level. Group 3 Sites (PICA-008) occupies approximately 40 acres in the northeastern portion of the Arsenal and encompasses three study sites: Sites 1, 2, and 4. Site 2 is located in this valley, with Site 1 on the ridge to the northeast, and Site 4 on the ridge to the southwest.

Originally Site 2 was operated by the Naval Air Rockets Test Station, a division of the U.S. Navy, and used for rocket testing, flare testing and training activities. Currently Site 2 is operated by the Armament Research, Development and Engineering Center, Munitions Engineering Technology Center, which is a division of the United States Army headquarters Munitions Systems & Technology Directorate. Buildings located in the northwest portion of the Site are used for homeland security training. The Outdoor Small Arms Firing Range is located within the G-2 area. The outdoor firing range serves as the development platform for new training practices for the PICA-Homeland Defense Training and Technology Test bed allowing the opportunity to observe training practices at all levels of government, including PICA and other federal agencies as well as state, county and local governments, involving military, law enforcement, and first responders.

A Ballistic Rail Gun had operated at Site 4 within Building 3620. A minimum of four additional buildings were devoted to ordnance disassembly, and Building 3611 was an instrument shop built in 1956-1957. Test Area E of Site 4 currently had five inactive structures (including Building 3627, which was the E-1D Control Room) and two inactive test stands. Site 4 was originally operated by the Naval Air Rocket Test Station division for rocket fuel and engine development similar to Site 1. Site 1 is inactive and contains former building structures and roadways.

#### **17.1.1 Land and Resource Use**

Current land use within the Group 3 Sites (PICA-008) is industrial. Historical and current use include various forms of rocket testing at all three Sites, rocket fuel development and engine redesign, small mine testing, Ballistic Rail Gun operations, and ordnance disassembly. Test Area E located in Site 4 is inactive. Test Area D of Site 4 is active, although all of the rocket test pads and stands are currently inactive and/or removed. The Ballistic Rail Gun, Building 3620, constructed in 1975 in the southern part of Test Area D, is still in operation. At least four buildings in Test Area D are devoted to operations, storage, and support. Three buildings are devoted to ordnance disassembly. Buildings 3612, 3628, 3603, 3618, and 3625 were demolished in 2014.

The future land uses planned at the Group 3 Sites (PICA-008) will ultimately remain as industrial and are anticipated to consist of training activities and research and development, as specified in the 2015 Real Property Vision Plan for PICA.

Use of groundwater beneath Group 3 Sites is restricted through the facility-wide CEA that applies to all groundwater beneath Picatinny in both the bedrock and unconfined aquifers. NJDEP identifies the CEA

as a well restriction area which functions as an IC for groundwater use. The CEA addresses all aquifers and COCs for Group 3 (PICA-008) groundwater.

#### 17.1.2 Physical Characteristics

Groundwater contamination at Site 2 primarily associated with CT and TCE is divided between the South and North Plume within the surficial aquifer; however low-level detections of CT and TCE detected within the bedrock aquifer between the two plumes, suggest the primary source of contamination is from Building 3515 and that the northern plume is formed from upwelling of the South Plume (Shaw, 2005).

Groundwater elevations associated with wells set in the surficial aquifer indicate that groundwater flows toward the G-2 Reservoir and Stillwell Pond, located in the low-lying areas of the valley floor. The average hydraulic conductivity as determined from aquifer testing was approximately 5 feet per day (ft/day) and average groundwater velocity is 0.3 ft/day (Shaw, 2005). Depths to groundwater, as measured during the groundwater sampling event in September 2015, ranged from 5 ft bgs at 2MW-25 to 13 ft bgs at 2MW47-102. A comparison of water levels at well pairs 2MW- 4/2MW-4D and 2MW-10/2MW-10D indicates that the vertical hydraulic gradients are downward from the unconfined unit into the bedrock unit within the northwestern portion of Site 2 but transition to an upward vertical gradient closer to the G-2 Reservoir, which is the probable discharge point.

#### 17.1.3 Site Chronology

**Table 17-1: Chronology of Site Events at Group 3 Sites**

Event	Date
RI field activities at Group 3 Sites	1997-1998
Final Group 3 RI Report Submittal	2001
Pilot-scale Test – nano-scale zero valent iron	2004-2005
Final Feasibility Study	2005
Pilot-scale Test – emulsified vegetable oil	2007
ROD signature	2009
Remedial Action, Well Install, Injection Event, Baseline Sampling	2010
Final Remedial Design	2010
Beginning of RAO and LTM activities	2010
Fourth Five-Year Review (first for Group 3 Sites)	2011
Second Injection Event	2013
Annual Monitoring and O&M Reports	2010-2015

#### 17.1.4 Initial Response

Two pilot-scale injection tests were performed prior the ROD to support remedy selection. A ZVI pilot-scale test was performed from September 2004 to January 2005. Testing consisted of injection of nano-scale ZVI at 2MW-20 and 2MW-21. Post pilot-test sampling conducted in early 2007 indicated that, while the observed decreases in concentrations of TCE and its degradation products due to the injection

of ZVI had been sustained, the levels of CT in a number of locations within the plume eventually rebounded to near historical levels. Clogging of the injection well screen also prevented follow-up injection events (Shaw, 2005).

A second pilot-scale injection test was conducted in August 2007 using a 2.5% emulsified vegetable oil (EVO) solution into one injection well. Results of this test were used as the basis of design for the selected remedy.

#### 17.1.5 Basis for Taking Action

Based on the results of previous site investigations, COCs were identified for groundwater and surface water. COCs were not identified for soil because soil contamination at this site is being addressed in a separate FS. The COCs in groundwater and surface water include:

- 1,1-DCE
- CT
- PCE
- TCE

The 2000 HHRA and supplemental assessments evaluated the current/future outdoor maintenance worker; current/future industrial/research worker; future construction worker; and, future on-site youth visitor. Groundwater uses evaluated dermal absorption by construction workers and ingestion/inhalation of drinking water by Picatinny workers. These studies found the groundwater COCs at Site 2 pose an unacceptable risk to human health for the hypothetical future industrial worker via the ingestion and inhalation groundwater pathways. Groundwater contact through any of these pathways is not expected to occur because of the facility-wide CEA and LUCs that are in place. Groundwater COCs also exceed applicable drinking water standards. A remedial action was required to address this unacceptable risk to human health and restore the groundwater to its beneficial use as a drinking water aquifer.

### 17.2 Remedial Actions: Group 3 Sites (PICA-008)

#### 17.2.1 Remedy Selection

The Final ROD for Group 3 Sites (PICA-008) was signed by the U.S. Army on July 8, 2010 and by the USEPA on August 2, 2010. The RAOs, as listed in the ROD, are as follows:

- To prevent human exposure to contaminated groundwater that would cause unacceptable risk over the duration of the RA;
- To achieve the more stringent of the Federal MCLs or NJGWQS for the identified COCs in a reasonable timeframe, thereby restoring groundwater to its beneficial use as a drinking water source;
- To achieve NJGWQS through remediation of groundwater for the identified COCs to ensure that groundwater remediation mitigates potential surface water impacts; and,
- To maintain current land-use (industrial) and current ICs at the Group 3 Sites (PICA-008).

The selected remedy included in-situ enhanced bioremediation, implementation of LUCs, and long-term groundwater monitoring. The purpose of the in-situ enhanced bioremediation is to reduce the mass loading of CT to the bedrock aquifer and to expedite the timeframe required to remediate the dissolved phase plume in the surficial aquifer.

Because volatile COCs were identified within groundwater at Group 3 Sites, vapor intrusion potential was considered. Vapor intrusion is not considered a current issue because there is only one building within the Group 3 Sites plume, and it is unoccupied and in a state of disrepair. However, in the event land use changed and any building located above the plume becomes occupied during the remedial action, then vapor intrusion sampling may be implemented, as outlined in the RD and ROD.

Specifically, one of the LUC objectives outlined in the RD includes a contingency for vapor intrusion sampling should any building located above the plume become occupied during the remedial action for groundwater. The selected remedy addresses volatile COCs in groundwater, therefore reducing future potential for vapor intrusion.

#### 17.2.2 Remedy Implementation

Remedy implementation spanned from August 2010 to September 2010. Six injection (2IW-2 through 2IW-7) and three monitoring wells (2MW-25, 26, and 27) were installed within the surficial aquifer in both the North and the South plume. Injection wells in the North Plume (2IW-4 and 2IW-5) are constructed from approximately 40 to 50 ft bgs within the surficial aquifer while the remaining injection wells are installed within the South Plume and constructed from approximately 20 to 30 ft bgs. No injection wells are constructed in the bedrock aquifer. Baseline sampling was conducted in August, to document site conditions prior to the injection event. A summary of injection events is provided in the following section.

**Section 4.5.2** discusses LUCs utilized at Picatinny and **Section 4.5.3** discusses the facility-wide CEA restrictions which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants. The LUCs associated with the Group 3 Sites remedy were documented in the RD (ARCADIS, 2010) and implemented in 2010. A site map depicting the LUC boundary is included on **Figure 17-2**.

#### 17.2.3 Systems Operations/O&M Requirements

Systems O&M since the previous FYR have included one injection event, performance monitoring, and compliance monitoring at groundwater and surface water locations, consistent with the programs outlined in the RD. The monitoring locations, frequency, and parameters are summarized in **Table 17-2** and **Figure 17-3**. A summary of injection events at Group 3 Sites is included in **Table 17-3**, below. The second injection event was considered supplemental and focused on the area with concentrations of TCE above 10 µg/L or in the vicinity of 2MW-17. Per the RD (ARCADIS, 2010), the objective of the active remedy (i.e. EVO injections) is to reduce CT and TCE concentrations in the source area to 25 µg/L and 10 µg/L, respectively. An MNA program will then monitor remaining concentrations of COCs. Performance monitoring results are evaluated against these concentrations thresholds to determine if additional injection events should be considered.

#### **Table 17-3: Injection Event Summary**

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Injection Event	Date	Carbon Substrate	2MW-20	2MW-21	2IW-1A	2IW-1B	2IW-2	2IW-3	2IW-4	2IW-5	2IW-6	2IW-7	Total Volume (gal)
Pilot (ZVI)	July 2005 - Jan. 2005	nano-scale ZVI	X	X									See Note 1
Pilot	Aug 15-16, 2007	2.5% by vol. EVO				X							1,600
First	Sept. 8-9, 2010	2-3% by vol. EVO			X	X	X	X	X	X	X	X	8,300
Second	May 6-9, 2013	1-2% by vol. EVO				X					X	X	3,200

**Notes:**

1 - Information unavailable for this review

2IW-4 and 2IW-5 associated with North Plume. All other injection wells in South Plume.

2MW-20 and 2MW-21 are between 2IW-2 and 2IW-3 and 7 ft upgradient of 2MW-10

EVO = emulsified vegetable oil

ZVI = zero-valent iron

LUC inspections and certifications have occurred annually during this review period in accordance with the LUC objectives outlined within the RD.

### 17.3 Progress Since Last Five-Year Review: Group 3 Sites

The protectiveness statement from the fourth FYR was:

*The remedy for Group 3 Sites (PICA-008) Groundwater is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

No issues or recommendations were included in the previous FYR.

Since the fourth FYR, one injection event and five years of performance, groundwater and surface water monitoring and LUC inspections have been completed. Progress towards meeting RAOs is discussed in **Section 17.4.2**.

### 17.4 Document and Data Review: Group 3 Sites

#### 17.4.1 Document Review

Relevant and appropriate documents associated with the Group 3 Sites remedy selection, implementation, and O&M were reviewed for this fifth FYR. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2009. Pre-Design Technical Memorandum for Groundwater and Sediment, Group 3, Sites 1, 2, and 4 (PICA-008), Picatinny Arsenal, New Jersey. July 2009. Final.

ARCADIS, 2010. Remedial Design for Groundwater and Surface Water, Group 3 Sites 1, 2 and 4 (PICA-008), Picatinny Arsenal, New Jersey. December 2010. Final.

PICATINNY ARSENAL  
FIFTH FIVE-YEAR REVIEW REPORT

ARCADIS, 2011. Interim Remedial Action Report. Group 3 Sites (PICA-008), Picatinny Arsenal, New Jersey. February.

ARCADIS, 2013. 2012 Annual Groundwater Data Repot. Group 3 Sites (PICA-008), Picatinny Arsenal, New Jersey. May.

ARCADIS, 2014. 2013 Annual Groundwater Data Repot. Group 3 Sites (PICA-008), Picatinny Arsenal, New Jersey. May.

ARCADIS, 2014. 2014 Annual Groundwater Data Repot. Group 3 Sites (PICA-008), Picatinny Arsenal, New Jersey. October.

EA, 2016. 2015 Internal Draft Annual Groundwater Data Repot. Group 3 Sites (PICA-008), Picatinny Arsenal, New Jersey. February.

IT Corporation (IT), 2000<sup>3</sup>. Phase II Ecological Risk Assessment, RI/FS, Picatinny Arsenal, New Jersey, 3 volumes. Prepared for U.S. Army Corps of Engineers – Baltimore District. Contract No. DACA-31-95-D-0083. February 2000.

Shaw, 2005. Group 3 Sites Feasibility Study, Picatinny, New Jersey. Prepared for U.S. Army Corps of Engineers – Baltimore District. Contract No. DACA31-95-D-0083. August. Final.

U.S. Army, 2010. Record of Decision for Groundwater and Surface Water at Group 3 Sites (PICA-008), Picatinny Arsenal, New Jersey. June 2010. Final.

#### 17.4.2 Data Review and Evaluation

The data evaluation was organized into three sections, including performance monitoring, compliance monitoring, and progress towards RAOs.

##### 17.4.2.1 Performance Monitoring

The purpose of the in-situ enhanced bioremediation is to reduce the mass loading of CT to the bedrock aquifer and to expedite the timeframe required to remediate the dissolved phase plume in the surficial aquifer. The RD established concentration thresholds for operation of injections and maintenance of the IRZ. The objective of the active remedy is to reduce CT and TCE concentrations in the source area to 25 µg/L and 10 µg/L, respectively (ARCADIS, 2010).

Monitoring results from September 2015 indicate concentrations are below the threshold for CT (50 µg/L) and TCE (10 µg/L) requiring active treatment. Monitoring results from the previous year in August 2015 showed six of the ten annual monitoring wells were near or above the active treatment threshold for TCE, ranging from 10 to 68.5 µg/L. The following observations were made after reviewing performance monitoring and VOC trend charts for the Group 3 Sites:

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<sup>3</sup> Document is referenced but was not reviewed.  
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- CT concentrations rapidly declined following initiation of injections in both the North and South Plumes.
- TCE concentrations at South plume performance wells 2MW-25 and 2MW-10 are near SCLs and have declined after both ZVI and EVO pilot studies and 2010 and 2013 EVO injection events were completed.
- TCE concentrations at the North plume performance well 2MW-14 have been steadily declining and with detections ranging from 5.0 to 10.8 µg/L since 2012.
- TCE concentrations have oscillated above or near 10 µg/L at the eastern most performance monitoring well 2MW-17 (68.5 µg/L in 2014) and to a lesser extent at downgradient wells 2MW-27 (14.6 µg/L in 2014), 2MW-26 (15 µg/L in 2014), MW47-101 (10.5 µg/L in 2014), and MW47-102 (13.6 µg/L in 2014). In September 2015, VC was detected at 2MW-17 at 19.3 µg/L; the molar equivalent of this concentration in TCE form is approximately 40 µg/L. Therefore the eastern portion of the South plume should continue to be monitored to determine whether a future injection event may be necessary.
- While elevated dissolved organic carbon (DOC) concentrations were not observed uniformly (e.g. radius of influence [ROI] wells 2MW-17 and 2MW-14), the presence of degradation products associated with CT and TCE, elevated methane, and general decline in total mass support the conclusion that injections have been effective in reducing COC mass within the plume.

#### 17.4.2.2 Compliance Monitoring Locations

The ten monitoring wells and five surface water sampling locations have been monitored for CVOCs according to the program outlined in the RD which are currently on an annual frequency (**Table 17-2, Figure 17-3**). According to the Draft Internal 2015 Annual Report, one of the locations, 2MW-5 could not be located during the 2015 event although the well was found in the March of 2016 and sampled. Historically, this well has had limited detections (less than 1 µg/L) of COCs below SCLs. Concentrations of COCs were less than 0.5 µg/L during sampling conducted in 2014. The following observations were made relative to wells and surface water trends within the compliance monitoring program:

- COC concentrations in bedrock well 2MW-4D, located between the North and South plume were below SCLs during the 2014 and 2015 monitoring events. Historical maximum concentrations for CT and TCE were 14.6 µg/L and 10.1 µg/L, respectively.
- COC concentrations in the South plume sentinel well 2MW-5, have historically been below SCLs, including the most recent monitoring event in 2014.
- During the 2015 sampling event:
  - CT was detected above the SCL of 1 µg/L in 2 of 9 monitoring wells sampled. The maximum concentration of CT was 5.8 µg/L in monitoring well



- TCE exceeded the SCL of 1 µg/L in 7 of 9 monitoring wells sampled. The maximum concentration of TCE was 9.8 µg/L in monitoring well 2MW47-101.
- Surface water results were below detection limits at all locations in 2014 and 2015 (for locations where surface water was present) and below SCLs for the duration of this review period (2011 through 2015).

#### 17.4.2.3 Progress Towards RAOs

Based on the pore flushing analysis presented in the RD, the overall timeframe for MNA is taken as the single longest time to achieve the SCLs within the three plume areas, which is driven by CT in the bedrock plume. These analyses indicate a remedial timeframe on the order of 22 years following EVO treatment. The RD estimated operation of the remedy would require approximately 7 years following remedy implementation or until 2017. A total remedial timeframe of 30 years was therefore assumed in the ROD. Injections have made progress towards reducing mass in the surficial aquifer and as of the 2015 event, concentrations are below the threshold values for CT (50 µg/L) and TCE (10 µg/L) that require active treatment or injections. While updated pore flushing calculations were not performed for this review, trends in CVOCs indicate the remedy is generally on track with original timeframe projections.

#### 17.4.2.4 Analysis of 1,4-Dioxane at Targeted Wells

During this review it was noted that 1,1,1-TCA has been detected in historical groundwater samples collected from Group 3 Sites. Due to 1,4-dioxane's widespread use as a stabilizer for 1,1,1-TCA, the two contaminants are commonly present together. A review of available data indicates that Group 3 Sites' groundwater has not been analyzed for the presence of 1,4-dioxane. Therefore, the next groundwater monitoring event should include analysis of 1,4-dioxane at select wells near the source area and at select wells immediately downgradient of the source area, given 1,4-dioxane's highly mobile properties.

### 17.5 Technical Assessment: Area B Groundwater

#### 17.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

##### 17.5.1.1 Remedial Action Performance

As stated in **Section 17.4.2.1**, the purpose of EVO injections is to reduce the mass loading of CT to the bedrock aquifer and to expedite the timeframe required to remediate the dissolved phase plume in the surficial aquifer.

Operation of injections (including pilot study activities) has been effective in decreasing plume concentrations of COCs, including primary CVOCs, CT and TCE. While 2015 groundwater results are below the threshold criteria that require maintenance of the IRZ, continued monitoring should be conducted to confirm TCE at well 2MW-17 and downgradient wells do not see a sustained rebound of

TCE above 10 µg/L. A review of trends in CVOCs at Group 3 Sites indicates the remedy is generally on track with original timeframe projections. Surface water results have also been below SCLs during the review period (2011 through 2015).

**Section 4.5.2** discusses LUCs utilized at Picatinny and **Section 4.5.3** discusses the facility-wide CEA restrictions which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants. The LUCs and CEA restrictions have successfully eliminated incidental exposure to site contaminants.

#### 17.5.1.2 Operations and Maintenance

Plume concentrations will continue to be monitored relative to threshold criteria for CT and TCE in the RD to determine whether future injection events are needed.

#### 17.5.1.3 Opportunities for Optimization

No optimization opportunities were identified.

#### 17.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified.

#### 17.5.1.5 Implementation of Land Use Controls and Other Measures

Land use controls inspections and certifications have occurred annually since remedy implementation in 2010. The LUC objectives established in the RD are being tracked within annual LUC and NFA monitoring reports in accordance with LUC objectives, and no issues or corrective actions have been identified within the reporting period. The facility-wide CEA restricts groundwater use and has been maintained through a biennial certification process.

### 17.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for tapwater and the New Jersey GWQC or Surface Water Quality Criteria (SWQC). Based on the comparison of SCLs in the ROD to RSLs and GWQC/SWQC, current groundwater and surface water concentrations at the site would not present an unacceptable risk. Therefore, cleanup levels selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

As discussed in **Section 17.2.1**, vapor intrusion is not considered a current issue because the one building located above the Group 3 Sites plume is unoccupied and in a state of disrepair; however in the

event land use changes and any building above the plume becomes occupied, then a VI analysis or sampling will be conducted as outlined in the ROD and RD. This FYR found that conditions at Group 3 Sites have not changed in a manner that would create a VI concern.

The RAOs are to prevent human exposure to contaminated groundwater over the duration of the RA and to achieve site cleanup of COCs in a reasonable timeframe. The RAOs remain valid as they do not allow for unacceptable risk to human health until the groundwater cleanup goals are met and maintains the current land use and ICs. The cleanup criteria is the more conservative of Federal MCLs or NJGWQS for COCs, and to be achieved within a reasonable timeframe. Data trends indicate the remedy is generally on track with original timeframe projections to meet the RAOs.

#### 17.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

##### 17.5.3.1 Ecological Risks

No new information has come to light that would call the protectiveness of the remedy into question. Surface water results have been below SCLs for the period of 2011 through 2015 with no detections in 2014 or 2015.

##### 17.5.3.2 Natural Disasters

There have been no natural disasters during the review period that could call the protectiveness of the remedy into question.

##### 17.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No new information has been found that could call into question the protectiveness of the remedy.

#### 17.5.4 Summary of Technical Assessment

The remedy has been implemented and is operating as intended by the ROD and RD. Injections have made progress towards reducing COC mass in the surficial aquifer and as of the 2015 event, concentrations are below the threshold values for CT (50 µg/L) and TCE (10 µg/L) that require active treatment or injections. Surface water results have been below SCLs for the duration of this review period. Performance and annual groundwater and surface water monitoring have been completed, consistent with the RD. Annual LUC inspections and maintenance of the facility-wide CEA restricting groundwater use ensure LUCs remain effective at restricting potential exposure to contaminated groundwater and surface water. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### 17.6 Issues: Group 3 Sites Groundwater

No issues have been identified that affect the current and/or future protectiveness.

## **17.7 Recommendations and Follow-up Actions: Group 3 Sites Groundwater**

No recommendations or follow-up actions were identified.

### **17.7.1 Other Recommendations**

As discussed in **Section 17.4.2**, the next groundwater monitoring event should include analysis of 1,4-dioxane at select wells near the source area and at select wells immediately downgradient of the source area.

## **17.8 Protectiveness Statement: Group 3 Sites Groundwater**

The remedy for Group 3 Sites (PICA-008) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. Injections have made progress towards reducing COC mass in the surficial aquifer and as of the 2015 event, concentrations are below the threshold values for CT (50 µg/L) and TCE (10 µg/L) that require active treatment or injections. Surface water results have been below SCLs for the duration of this review period.

Performance and annual groundwater and surface water monitoring have been completed, consistent with the RD. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring and injection systems has been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 18.0 Group 1 Sites (PICA-079)

### 18.1 Background: Group 1 Sites

Group 1 is approximately four acres in size and encompasses four sites: 40, 93, 156, and 157 (**Figure 18-1**). Site 40 consists of Buildings 809 and 810; Building 809 was originally constructed for use as a large-caliber projectile washout facility, and Building 810 was originally intended as an operating facility. Currently the buildings are used as an explosives wastewater treatment plant and a melt-pour research facility. Site 93 used to consist of both Buildings 800 and 807; however, Building 800, first built as a loading facility for loading submissiles into warheads, has since been demolished. The only building currently standing at Site 93 is Building 807. Building 807 was originally constructed as a receiving, cleaning and inspection facility, but is currently used for cold storage and for staging packing materials for Building 820 (Site 157).

Site 156 consists of Buildings 813, 816, and 816-B. Originally, Building 813 was constructed for use as a production facility for large-caliber projectiles. Currently, this building is utilized as a remote automated control facility for Building 810 (Site 40). Building 816 was constructed as an assembly facility for primer, propellant, and cartridge cases.

Site 157 consists of Buildings 820, 823, and 824. Both Building 820 and Building 823 were constructed to be used as large-caliber projectile loading plants. Building 824 is ancillary to Building 823. Building 820 has since been reactivated as an ammunition repack and surveillance facility.

During the Remedial Investigation, explosives compounds were detected in the groundwater beneath Sites 40 and 157. Historical groundwater data showed the presence of two commingled plumes of 2,4,6-trinitrotoluene (TNT) and RDX, one at Site 40 and one at Site 157.

Group 1 is situated on the northeast shore of Picatinny Lake, the groundwater flow direction from Site 157 and Site 40 is towards the lake. Two distinct aquifers, the unconsolidated and bedrock, were characterized during previous investigations. The unconsolidated aquifer was encountered along the entire western shore of Picatinny Lake and in peninsulas, which extend into the lake (with the exception of Site 156) where competent bedrock was encountered at less than 10 ft bgs. This aquifer is thickest along the shores of the lake adjacent to the peninsula and pinches out where the bedrock is close to the ground surface. The total thickness of this aquifer in the Group 1 area is approximately 100 ft.

#### 18.1.1 Site Chronology

**Table 18-1: Chronology of Site Events at Group 1 Sites Groundwater**

Event	Date
Site investigations	1995-2001
Phase II Group 1 Sites Remedial Investigation Report, Sites 40, 93, 156, & 157	2002
Group 1 Feasibility Study Data Gap Investigation	2002-2003
Final Group 1 Sites Feasibility Study	2005
Pre-Design Technical Memorandum.	2009
Record of Decision	2010
Final Remedial Action Work Plan	2010

PICATINNY ARSENAL  
FIFTH FIVE-YEAR REVIEW REPORT

Event	Date
Interim Remedial Action Report	2011
2010 Annual Land Use Certification and Groundwater Data Report	2011
Fourth Five-Year Review (first for Group 3 Sites)	2011
Annual Monitoring and Land Use Certification Reports	2011-2015

### 18.1.2 Basis for Taking Action

Based on the results of previous site investigations, COCs were identified for surface soil, subsurface soil and groundwater. The COCs in surface soil, soil, and groundwater are summarized below in **Table 18-2**.

**Table 18-2: Group 1 Sites COCs**

COC	Surface Soil	Non-surface soil	Groundwater
arsenic	X	X	
barium	X		
lead	X		
benz(a)anthracene	X	X	
benzo(a)pyrene	X	X	
benzo(b)fluoranthene	X	X	
benzo(k)fluoranthene	X		
dibenz(a,h)anthracene	X	X	
indeno(1,2,3-cd)pyrene	X		
PCBs (Aroclor 1260)	X	X	
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	X		
Pentaerythritol tetranitrate	X		
Picric acid (surface soil only)	X		
Cyclotrimethylenetrinitramine (RDX)	X	X	X
Tetryl	X	X	
1,3,5-trinitrobenzene	X		
2,4-dinitrotoluene	X	X	
2,4,6-trinitrotoluene (TNT)	X	X	X
2-amino-4,6-dinitrotoluene			X
4-amino-2,6-dinitrotoluene			X

The 2002 HHRA evaluated the current/future outdoor maintenance worker, current/future industrial/research worker, current site workers, current/future construction worker, and, future on-site youth visitor. The HHRA concluded contaminants (primarily RDX and TNT) in soil and groundwater at the Group 1 Sites (PICA-079) pose an unacceptable risk to humans for the current and reasonably anticipated future users. Risk characterization is summarized separately for each site in the ROD for Group 1 Sites (PICA-079). A remedial action for soil was required to mitigate this unacceptable risk posed by explosives. Groundwater pathways evaluated dermal absorption by construction workers and ingestion/inhalation by drinking water by Picatinny workers. These studies found the groundwater COCs at Sites 40, 156, and 157 pose an unacceptable risk to human health for the hypothetical future industrial worker via the ingestion and inhalation groundwater pathways. Groundwater contact through

any of these pathways is not expected to occur because of the facility wide CEA and LUCs that are in place. Groundwater COCs also exceed applicable drinking water standards. A remedial action was required to address this unacceptable risk to human health and restore the groundwater to its beneficial use as a drinking water aquifer.

A BERA was conducted at the Group 1 Sites as part of the Phase II RI. The purpose of the BERA was to evaluate the potential risk to aquatic, benthic, and terrestrial receptors associated with exposure to chemicals in the environmental media under current conditions at each site. With the exception of Site 40 and Building 823 of Site 157, all of the Group 1 Sites were characterized as non-forested lands with little suitable habitat to attract wildlife in the sample areas. Thus, ecological assessments of these areas were not warranted and were eliminated from consideration in the Phase II ERA. Results of the ERA for Site 40 and 157 are summarized in the ROD for Group 1 Sites (PICA-079).

## 18.2 Remedial Actions: Group 1 Sites

### 18.2.1 Remedy Selection

The Final ROD for Group 1 Sites (PICA-079) was signed by the U.S. Army on July 28, 2010 and by the USEPA on September 16, 2010. The RAOs as listed in the ROD for Group 1 Sites (PICA-079) are as follows:

- To prevent human exposure to contaminated groundwater that would cause unacceptable risk over the duration of the RA
- To achieve the more stringent of the Federal MCLs or NJGWQS for the identified COCs in a reasonable timeframe, thereby restoring groundwater to its beneficial use as a drinking water source. For RDX and TNT, which have no established MCL or NJGWQS, the Health Advisory Level (HAL) will be used as the cleanup goal
- To address soils with contaminants driving risk for the sites greater than  $1 \times 10^{-4}$  or HIs greater than 1
- To manage soils with calculated risk in the risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  following NCP guidance

The selected remedy included excavation and off-site disposal of explosive-impacted soils, implementation of LUCs, and MNA of explosives in groundwater.

### 18.2.2 Remedy Implementation

In September 2010, a total of 405 tons of non-hazardous, explosives-impacted soil was excavated from an area comprising approximately 4,290 sf and disposed of at an off-site facility. Confirmatory samples were collected and excavations were backfilled to original elevations and vegetated. Implementation of LUCs was conducted subsequent to excavation activities and will be maintained until contaminant levels allow for unlimited use and unrestricted exposure. The LUCs maintain the integrity of the monitoring system, and prohibit the development of the site for residential housing, schools, or child care facilities. The facility-wide CEA discussed in **Section 4.5.3** further restricts use of groundwater. A site map with the LUC area of applicability is included as **Figure 18-1**.

### 18.2.3 Systems Operations/O&M Requirements

To implement the selected RA for groundwater, MNA sampling was conducted in accordance with the monitoring program specified within the 2010 Remedial Action Work Plan (RAWP). Thus far, MNA sampling has been conducted starting September 2010 with the latest sampling event in September 2015. Sampling included the collection of groundwater samples using Hydrasleeves™ from ten monitoring wells. The RAWP specified only one sediment and surface water location for sampling; however, one additional sediment and surface water sample location have been added at the request of NJDEP. Therefore a total of 12 sample locations are being sampled. Sampling locations are shown on **Figure 18-2**.

### 18.3 Progress Since Last Five-Year Review: Group 1 Sites

The fourth FYR was the first time the Group 1 Sites was included in the FYR. The protectiveness statement from the fourth FYR was:

*The remedy for Group 1 Sites (PICA-079) is functioning as intended and is protective of human health and the environment. Currently there is no unacceptable exposure to human health or environmental receptors from site contaminants, and no unacceptable exposures are expected over the next five years.*

No issues or recommendations were included in the previous FYR.

Subsequent to the fourth FYR, MNA monitoring of groundwater wells and surface water/sediment sample locations has been conducted. Annual inspections and LUC Certifications have been completed.

### 18.4 Document and Data Review: Group 1 Sites

#### 18.4.1 Document Review

Relevant and appropriate documents associated with the Group 1 Sites (PICA-079) investigations, remedy development, and operations were reviewed for this fifth Five-Year Report. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2010. Final Remedial Action Work Plan Group 1 Sites (PICA-079) U.S. Army Garrison Picatinny Arsenal, New Jersey September 2010.

ARCADIS, 2011. Draft Final Interim Remedial Action Report. April.

ARCADIS, 2014a. 2013 Annual Monitoring Report, Group 1 Sites (PICA-079), Picatinny Arsenal, New Jersey, May.

ARCADIS, 2014c. 2014 Annual Monitoring Report, Group 1 Sites (PICA-079), Picatinny Arsenal, New Jersey, November.

EA, 2016. Internal Draft 2015 Annual Monitoring Report Group 1 Sites (PICA-079). January.

U.S. Army. 2010. Record of Decision for Group 1 Sites (PICA-079), Picatinny Arsenal, New Jersey. July. Final.



#### 18.4.2 Data Review and Evaluation

Groundwater monitoring has been on-going since September 2010. Groundwater data from twelve sampling events were reviewed for Site 40 and from seventeen events for Site 157. Analytical data is tabulated in **Figures 18-3a** through **18-3c**.

##### 18.4.2.1 Site 40

Monitoring wells 40MW-1, 40MW-2, 40MW-3 and 40MW-6 remain at concentrations over the SCL for either RDX, TNT or both compounds. A maximum concentration of 211 µg/L (RDX) and 523 µg/L (TNT) was reported in samples from 40MW-2 since the last Five Year update. Mann-Kendall statistical trend analysis was conducted at wells with positive detections from September 2010 through September 2015 (**Figures 18-3a** and **18-3b**). The results of the Mann-Kendall analysis for Group 1 Site 40 wells suggest stable or decreasing trends for TNT and RDX. Although the statistical analysis indicates that 40MW-6 exhibits an increasing trend for TNT.

##### 18.4.2.2 Site 157

Monitoring wells 157MW-1, 157MW-2 and 157MW-3 remain at concentrations over the SCL for RDX, and 157MW-3 remains at concentrations over the SCL for TNT. The RDX sample results from wells in Group 1 Site 157 indicate no trend (157MW-1 and 157-MW-6S), stable (157MW-2 and 157MW-3), and probably decreasing trend (157MW-4), as shown on **Figure 18-3c**. Monitoring well 157MW-3 statistical analysis shows an increasing trend for TNT.

##### 18.4.2.3 Sediment and Surface Water Samples

In 2013, sediment samples from 79SD-2 exceeded the SCL for TNT (May and November) and RDX (November); however sediment samples collected in 2014 and September 2015 were below the SCL for TNT and RDX. The surface water sample collected at 79SW-1 in April 2014 exceeded the SCL with a RDX concentration of 3.99 µg/L. None of the other surface water samples collected in 2013, 2014 or 2015 exceeded the SCL.

### 18.5 Technical Assessment: Group 1 Sites

#### 18.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

##### 18.5.1.1 Remedial Action Performance

The remedy for explosives in soil was implemented in 2010, and the Interim RAR documents the removal of all explosives impacted surface soils which were above the established SCLs. LUCs and engineering controls are in place and inspected and certified annually. The LUCs maintain the integrity of the monitoring system, and prohibit the development of the site for residential housing, schools, or child care facilities.

The ROD (U.S. Army 2010) stated the timeframe to achieve the SCLs for TNT and RDX at Site 40 is approximately 11 years and 9 years, respectively. Similarly, the remedial timeframe to achieve SCLs at Site 157 for TNT and RDX is 8 years. However, a re-evaluation of the pore flushing model presented within the RAWP (ARCADIS 2010) using the peak concentrations for RDX and TNT observed since 2010 and current groundwater gradients indicate the remedial timeframe may be closer to 30 to 40 years (ARCADIS 2014).

#### 18.5.1.2 Operations and Maintenance

Groundwater use that could result in unacceptable risks to human health is controlled through the CEA and LUCs. The CEA is updated every two years and the LUCs are certified annually.

#### 18.5.1.3 Opportunities for Optimization

The Mann-Kendall trend analysis (**Figures 18-3a** through **3c**) indicate monitoring wells with the highest concentrations are not decreasing (with the exception of 40MW-2). The NJDEP noted in the approval letters to the 2013 and 2014 sampling events that the Army may choose to do additional groundwater remediation to shorten the MNA timeframe of 30 to 40 years.

#### 18.5.1.4 Early Indicators of Potential Issues

Groundwater concentrations of RDX and TNT remaining in the monitoring wells five years after implementation of the ROD remain in exceedance of SCLs and may be discharging to the lake. However, discharges to lake or sediments are to be addressed as part of the Picatinny Lake FS.

#### 18.5.1.5 Implementation of Land Use Controls and Other Measures

LUCs and engineering controls are in place and inspected and certified annually. The facility-wide CEA restricts groundwater use at the site, thereby limiting potential exposure to contaminants. Potential off-site migration to the adjacent Picatinny Lake is mitigated through use restrictions enforced on the lake which include prohibition of swimming or consuming fish and wildlife from the lake. Furthermore, the lake is not used as a drinking water source.

### 18.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for tapwater or industrial soil and the applicable New Jersey standard (GWQC or NRDCSCC). Based on the comparison of SCLs in the ROD to RSLs and the applicable New Jersey standard, current groundwater and soil concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy is likely protective of ecological receptors; however a protectiveness determination has

been deferred until the Picatinny Lake FS can fully evaluate potential risks associated with explosives in surface water and sediment. This comparison is presented in **Appendix 4**.

The RAOs remain valid as they prevent exposure to groundwater until cleanup goals can be achieved, and by eliminating unintentional exposure to contaminated soils. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment. The RAOs do not protect against migration of contaminated groundwater to the adjacent Picatinny Lake. The presence of contamination at Picatinny Lake is currently being evaluated under a FS.

#### 18.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

##### 18.5.3.1 Ecological Risks

No additional information has come to light regarding any ecological risks that could call into question the protectiveness of the landfill RA. The NJDEP noted in the approval letters to the 2013 and 2014 sampling events that explosives detected in the sediments are being evaluated for hot spot excavation as part of the Lakes FS.

##### 18.5.3.2 Natural Disasters

No natural disaster have occurred that call into question the protectiveness of the remedy.

##### 18.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

Sporadic detections of RDX and 2,4,6-TNT in sediment and RDX detections in surface water, as discussed in **Section 18.2.4.3**, indicate contaminant migration towards Picatinny Lake.

#### 18.5.4 Summary of Technical Assessment

The remedy has been implemented and is operating as intended by the ROD and RD. Excavation of explosives impacted soil and monitoring of groundwater, surface water, and sediment has been conducted, in accordance with the RD and program adjustments documented in the annual reports. The Mann-Kendall trend analysis performed in support of this review, indicates monitoring wells with the highest concentrations are not decreasing (with the exception of 40MW-2); however the most recently estimated timeframe to meet RAOs is approximately 30 to 40 years from remedy implementation in 2010. While groundwater impacted with explosives may be discharging to Lake Picatinny, surface water and sediments associated with Lake Picatinny are being addressed as part of the Lakes Feasibility Study. Annual LUC inspections and maintenance of the facility-wide CEA restricting groundwater use ensure LUCs remain effective at restricting potential exposure to contaminated groundwater and soils. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or SCLs have occurred which impact the protectiveness of the remedy.

## **18.6 Issues: Group 1 Sites**

The Lake Picatinny FS that is currently being conducted will determine if there are unacceptable risks associated with discharge of explosives in groundwater to Lake Picatinny and if the current remedy at Group 1 Sites is adequately addressing these risks.

The NJDEP noted in the approval letters to the 2013 and 2014 sampling event that explosives detected in the sediments are being evaluated for hot spot excavation as part of the Lakes FS. Because this issue falls under the scope of the Lakes Picatinny FS, it is not being evaluated under the Group 1 Sites.

## **18.7 Recommendations and Follow-up Actions: Group 1 Sites**

Recommend completing the Lake Picatinny FS and reevaluating the protectiveness of the current Group 1 Sites remedy.

### **18.7.1 Other Recommendations**

As noted under **Section 18.5.1.3**, monitoring wells with the highest concentrations are not decreasing (with the exception of 40MW-2). The NJDEP noted in the approval letters to the 2013 and 2014 sampling events that the Army may choose to do additional groundwater remediation to shorten the MNA timeframe of 30 to 40 years. Additional information may be needed to determine if the remedy, as is, will be able to achieve SCLs within the estimated timeframe. The Army may need to conduct additional remedial timeframe estimates every two years until such time as site groundwater data demonstrate a decreasing trend. In addition, during the next annual sampling event, a subset of monitoring wells shall be analyzed for perchlorate and reported in the annual report. The subset will include monitoring wells along the longitudinal axis of the plume and/or wells representing the areas with highest concentrations of explosives and few locations downgradient.

## **18.8 Protectiveness Statement: Group 1 Sites**

A protectiveness determination of the remedy for Group 1 Sites (PICA-079) cannot be made at this time until further information is obtained.

There is currently no outward evidence of ecological harm; however, the Army is conducting the Lake Picatinny FS to determine if there are any residual risks that have not been adequately addressed by the actions at Group 1 sites. The determination of protectiveness for human health and the environment is being deferred until further information is obtained. Further information will be obtained by continued groundwater monitoring as well as quarterly monitoring of surface water and sediment and completion of the FS for Lake Picatinny. It is expected that this information will be obtained by December 31, 2017, at which time a protectiveness determination will in the form of an addendum to the FYR Report.

Excavation of explosives impacted soil and monitoring of groundwater, surface water, and sediment has been conducted, in accordance with the RD and program adjustments documented in the annual reports. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure that monitoring systems and signs have been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective. ICs currently assure protection of human health.

## 19.0 Site 34 (PICA-002) - Former Lower Burning Grounds

### 19.1 Background: Site 34

Site 34 (PICA-002) – Former Lower Burning Ground comprises approximately seven acres and is located near the southern boundary of Picatinny Arsenal along the banks of GPB (**Figure 19-1**). The burning grounds have been primarily utilized for the burning of explosive and explosive-contaminated material generated at Picatinny Arsenal. Additionally, the area has been used for landfilling and storage of wastes.

The burning grounds consists of low-lying swampy areas, with the exception of the Open Burning Area, which is located along the western side of the site. Direct burning on the ground in this area was discontinued in 1985, and wastes have since been placed in large metals pans on concrete supports for ignition, burning, and proper disposal. Operations in the Open Burning Area included the destruction of off-specification explosive constituents and “flashing” of contaminated metal and equipment (the decontamination of surfaces contaminated with explosive residue) within nine metal burning pans. The burning pans are used to dispose of explosives, powder, spent solvents, propellants, dust from wet vacuum filtration systems, and explosives-contaminated wastewater treatment sludge and sediment. The pans were lined with different materials that were compatible with the specific types and burning properties of the wastes to be burned. Materials were placed in the pans with oil and excelsior and then ignited. These operations were regulated under the interim status within a RCRA Part B permit. After treatment, metals munitions casing material was recycled. The destruction and flashing of off-specification materials was discontinued in 2011 and has since been inactive. In order to fill the low-lying areas of the Site, landfilling operations occurred from 1960 to 1980 in the northern portion of the Burning Ground known as the Landfill Area. “Flashed” metal was stored in the Waste Pile Area until the spring of 1991. Since then salvageable material has been removed from this area. Residual exposed debris, consisting mainly of cement, bricks, and wood, is evident on the ground in both the Landfill Area and Waste Pile Area.

#### 19.1.1 Site Chronology

**Table 19-1: Chronology of Site Events at Site 34**

Event	Date
Final Feasibility Study	2001
ROD signed by the USEPA	2005
Third Five-Year Review (first for Site 34)	2006
Fourth Five-Year Review (second for Site 34)	2011
Final Phase I Munitions and Explosives of Concern Work Plan	2012
Final Explanation of Significant Differences signed	2014
Final Phase II Remedial Action Work Plan and Addendum	2014
Remedial Construction	2014
Annual LUC Inspections	2014-2015
Stormwater System Modification	2014
Annual Monitoring Report	2015-2016

#### 19.1.2 Basis for Taking Action

The Army's RI of the Former Lower Burning Grounds occurred in 1993 and 1994 and indicated contamination of surface and subsurface soil and to a lesser extent, groundwater. Contaminants in surface soil included PAHs, PCBs, metals, dioxins, and furans. These contaminants were detected to a lesser extent in subsurface soils. COCs were not identified for groundwater; however LTM of metals in groundwater and surface water is being conducted to verify protection of human health and the environment following cap installation and to meet substantive RCRA requirements. COCs in soil, as identified in the ROD, include:

- benz(a)anthracene
- benzo(a)pyrene
- benzo(b)fluoranthene
- dibenzo(a,h)anthracene
- indeno(1,2,3-cd)pyrene
- arsenic
- cadmium
- copper
- lead
- total PCBs
- dioxins/furans

The 1998 HHRA for Site 34 (PICA-002) included exposure scenarios to soil and groundwater for the current site workers and future commercial/industrial workers. The results of the HHRA indicated that under the current and hypothetical exposure scenarios, the excess lifetime carcinogenic risk posed by contaminants exceeded the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ . A remedial action was required to mitigate this unacceptable risk.

Two ERAs were completed at the Former Lower Burning Grounds to evaluate the potential risks to ecological receptors from estimated exposures to hazardous constituents associated with the Former Lower Burning Grounds. A screening-level ERA was conducted as part of the Picatinny Arsenal Burning Ground Remedial Investigation Report and a second ERA was completed as part of the Picatinny Arsenal Phase I Risk Assessment. Different contaminant receptors were assessed as part of each ERA. Results of both ERAs are summarized in the ROD for the Former Lower Burning Grounds. Based on the results of the Phase I ERA, Site 34 was classified as a Group 1 site. Group 1 sites are areas for which both suitable habitat for assessment species and elevated concentrations of COPCs exist, and include those sites that potentially pose ecological risks based on current conditions that are sufficiently elevated to warrant risk management attention.

### 19.2 Remedial Actions: Site 34

#### 19.2.1 Remedy Selection

The ROD for the Former Lower Burning Grounds was signed on September 8, 2005.

The RAOs, as developed in the ROD, are as follows:

- Reduce the risk to the future on-site worker from exposure to surface soils with concentrations of the COCs that exceed the respective RGs.
- Reduce the risk to the future on-site worker from exposure to subsurface soils with concentrations of the COCs that exceed the respective RGs
- Control erosion and transport of sediments from the site to surrounding drainage features.
- Mitigate any potential ecological risk and protect the environment.
- Prevent or mitigate impacts to groundwater that may result from the leaching of contaminants from Burning Ground soil via groundwater infiltration.
- Manage potential groundwater risk at points of compliance.

The selected remedy for Site 34 (PICA-002) included the following components:

- Installation of an asphalt cap (modified by the Explanation of Significant Differences [ESD] to a hybrid soil and asphalt cover),
- Long-term groundwater and surface water monitoring, including the installation of one monitoring well in the shallow unconfined aquifer, and
- Implementation of LUCs.

#### 19.2.1.1 Explanation of Significant Differences

Because site operations continued at Site 34 (PICA-002) until June 2011, the selected remedy included in the 2005 ROD had not been implemented. During this period of delay between when the ROD was signed (2005) to the implementation of the remedy (2014), NJDEP promulgated new surface water quality standards (SWQSS). These regulations classified GPB as a C-1 waterway, thus introducing more stringent stormwater and land use regulations at the Former Lower Burning Grounds. The Army, the USEPA, and the NJDEP determined that the best way to comply with new regulations was to use a hybrid capping approach that includes both soil and asphalt covers. The USEPA determined an ESD was necessary to document the hybrid capping approach and to identify this change as a significant, but not fundamental, change to the selected remedy. The Final ESD was signed in 2014. The basis of the ESD was to document the hybrid capping approach required in order to comply with newly amended and/or promulgated regulations.

#### 19.2.2 Remedy Implementation

The remedial action was completed in 2014 and documented in the RAWP, RAR, and RAR Addendum. A brief summary is presented in this section. The remedial action consisted of the following components:

- Hybrid soil and asphalt cover (**Figures 19-2 and 19-3**):

- An impermeable asphalt cap (1.7 acres) over the portion of the site with the highest soil lead concentrations which could potentially leach to groundwater;
- Soil cover (5.8 acres) over the remainder of the Former Lower Burning Grounds.
- Permanent stormwater control features to manage runoff generated from hybrid cap (**Figures 19-2 and 19-3**), including:
  - Bio-retention infiltration pond (modified in December 2014 to allow discharge to surrounding wetlands after treatment for total suspended solids through a rip-rap apron).
  - Central swale
  - Diversion berm (removed in December 2014 to allow discharge to surrounding wetlands)
- Constructed wetlands at two nearby areas (i.e., Mitigation Sites #1 and #2, **Figure 19-4**) to compensate for the removal of wetlands at the Former Lower Burning Grounds as part of the RD
- Implementation of a LTM program (**Figure 19-5**) for groundwater and surface water and monitoring and maintenance of LUCs (**Figure 19-1**)
- Other activities supporting the RA included:
  - Munitions and Explosives of Concern (MEC) clearance and/or avoidance during any intrusive activities
  - Monitoring well protection and abandonment (9 monitoring wells abandoned and 8 modified by extension or reinstallation)
  - Existing structure demolition, disposal, and asbestos material management
  - Import and placement of sub-base soils
  - Stabilization of some on-site fill material due to excess moisture
  - Import and placement of fill material to bring the hybrid cap to final grades
  - Grading the existing asphalt road to match the final grades of the asphalt cap

The primary component of the Former Lower Burning Grounds remedy involved installation of the soil and asphalt cover (**Figure 19-2**). The asphalt cover was constructed to prevent contact with impacted soils exceeding site SCLs and limit infiltration into soils with potential for leaching lead into the groundwater. Both covers required preparation of the sub-base through grading to meet the final grading plan (**Figure 19-2b**) and in some cases stabilization due to excessive moisture. Both covers also included a geotextile overlying the sub-base to demarcate impacted or potentially impacted soils. The asphalt cover included 12-inches of densely graded aggregate and 4-inches of hot-mix asphalt over the geotextile. The soil cover included 18-inches of soil and 6-inches of organic top soil to support vegetation. A minimum of 2-feet of soil cover was placed above the geotextile.



Due to the increase in impermeable surfaces, a stormwater management system was also installed. Stormwater controls were also necessary because GPB is classified as a Category 1 Stream, and the Former Lower Burning Grounds lies within the 300 foot riparian zone associated with GBP; therefore the stormwater management system needed to meet substantive NJDEP requirements for stormwater.

After remedy installation in May 2014, field observations indicated that the infiltration basin was not draining as quickly as designed and also threatened to inundate the adjacent asphalt cover. The lower than anticipated infiltration rates and higher water table were attributed to the slow drainage but also exceeded the 72-hour drainage timeframe required by New Jersey's water quality regulations. In December 2014, the stormwater controls were modified to discharge to the surrounding wetlands by 1) removal of the southwestern berm (**Figure 19-3**), 2) re-grading to connect the basin to the surrounding wetlands and redistribute berm soils, and 3) placement of riprap where the central swale enters the basin to reduce TSS loading to surrounding wetlands.

The 2005 ROD also required that the site be remediated to support future military/industrial use. In 2015, a solar panel field was installed on top of the asphalt cover. Site operations are not expected to adversely affect environmental restoration activities or disturb wetlands outside the cover, and conversely, the Former Lower Burning Grounds site maintenance is not expected to adversely affect operation of the solar panel field.

Because the hybrid cap resulted in disturbance of soil and surrounding vegetation within regulated freshwater wetlands, associated transition areas, and flood hazard areas, wetland mitigation activities were required. To compensate for the permanent displacement of wetlands associated with the soil cover, 12 acres of degraded wetlands were enhanced at two sites nearby the Former Lower Burning Grounds (**Figure 19-4**) per the NJDEP's Freshwater Wetlands Protection Act Rules (New Jersey Administrative Code 7:7A) and Flood Hazard Area Control Act Rules.

Wetland mitigation at these two sites included clearing vegetation at both sites through application of an herbicide and removal of dead vegetation. A series of shallow depressions and in some cases berms were constructed to restore microtopographic complexity. Finally, the areas were seeded with wetlands-compatible vegetation as detailed in Appendix J of the RAR (ARCADIS, 2014c).

As documented in the previous FYR, a monitoring well was installed in 2010 along GPB and constructed in the shallow unconfined aquifer in accordance with the ROD. A full round of groundwater sampling was conducted shortly after installation.

### 19.2.3 Systems Operations/O&M Requirements

The LTM program for groundwater and surface water has been implemented as described in the RD. The monitoring network consists of the following, as presented on **Figure 19-5**:

- seven compliance monitoring wells constructed in the shallow aquifer (approximately 10 to 20 ft bgs) and located along GBP
- two monitoring wells constructed in the lower unconfined unit (approximately 124 to 151 ft)
- three surface water locations including one location upgradient, adjacent to, and downgradient of the Former Lower Burning Grounds

All locations have been sampled quarterly starting in 2014 and analyzed for TAL metals. The first two quarters established a baseline before cover installation. Per the design, groundwater samples have been collected on a quarterly sampling frequency for the first two years following remedy implementation and then will be reduced to semi-annual frequency thereafter. If a stable or decreasing trend is established, then the monitoring frequency may be reduced further with the U.S. Army, the USEPA, and the NJDEP concurrence.

The first comprehensive inspection and maintenance report following the storm water controls modification occurred in 2016. A review of the 2014 and Internal Draft 2015 Annual Land Use Certification and NFA Monitoring reports indicated no issues with the integrity of the soil and asphalt cap and that signs demarcating an environmentally restricted area and the limits of the cover were appropriately placed.

The first annual wetlands monitoring and maintenance report will be completed in 2016 and was not available for this review. Per the wetlands mitigation report, future wetlands maintenance activities will be documented annually in a memorandum summarizing: 1) selected herbicide, (2) time of application, (3) acreage of application, (4) targeted species, (5) amount of herbicide applied, and (6) any other wetlands maintenance activities. The wetlands mitigation areas include an area within Site 20/24 and in Site 78 wetland areas as shown on **Figure 19-4**.

### **19.3 Progress Since Last Five-Year Review: Site 34**

The protectiveness statement from the previous FYR was:

*The remedy for Site 34 (PICA-002) has not yet been implemented, and therefore the functionality of the remedy cannot be determined for Site 34 (PICA-002). The HHRA (Dames and Moore, 1994 and Dames and Moore, 1998) determined the risk to the current site worker is  $3.4 \times 10^{-05}$ . Therefore, it can be determined that under the current site use, the site conditions are protective of human health and the environment.*

The primary recommendation from the third and fourth FYR was “Submit the Remedial Design Plan, including the LUCIP and Long-Term Monitoring Plan, to EPA as soon as possible. Close the current Burning Ground (Site 35) and implement the remedy.”

During the third and fourth FYR, the remedy had not been implemented because the Former Lower Burning Grounds was still in use. Since the previous review, the Former Lower Burning Grounds was closed, the RD was completed and the remedy implemented in 2014.

### **19.4 Document and Data Review: Site 34**

#### **19.4.1 Document Review**

Relevant and appropriate documents associated with the Former Lower Burning Grounds remedy selection, implementation, and O&M were reviewed for this fifth FYR. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS, 2014a. Phase II Remedial Action Workplan. U.S. Army Garrison Picatinny Arsenal, New Jersey. April.

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- ARCADIS, 2014b. Phase II Remedial Action Work Plan, Addendum One, Munitions and Explosives of Concern Work Plan. Site 34 (PICA-002), Lower Burning Ground. U.S. Army Garrison Picatinny Arsenal, New Jersey, April.
- ARCADIS, 2014c. Remedial Action Report Site 34 (PICA-002). U.S. Army Garrison Picatinny Arsenal, New Jersey. November.
- ARCADIS, 2014d. 2014 Wetlands Mitigation Report Site 34 – Lower Burning Ground (PICA-002). U.S. Army Garrison Picatinny Arsenal, New Jersey. November.
- ARCADIS, 2014e. 2014 Annual Monitoring Report Site 34 – Lower Burning Ground (PICA-002). U.S. Army Garrison Picatinny Arsenal, New Jersey. November.
- ARCADIS, 2014f. Remedial Action Report Addendum – Stormwater Management System Modification Site 34 (PICA-002), Lower Burning Ground. U.S. Army Garrison Picatinny Arsenal, New Jersey. December.
- EA, 2016. Internal Draft 2015 Annual Monitoring Report Site 34-Lower Burning Ground (PICA-002) Groundwater and Surface Water. January.
- United States Department of the Army (U.S. Army), 2005. Picatinny Record of Decision, Site 34 – The Burning Ground. January. Final.
- U.S. Army, 2014. Final Explanation of Significant Differences, U.S. Army Garrison Picatinny Arsenal, New Jersey, April.

#### 19.4.2 Data Review and Evaluation

At the time of this review only four sampling events following remedy implementation and two baseline events were available for review. While the statistical analysis conducted after eight quarterly sampling events following remedy implementation will have more bearing on monitoring recommendations, a cursory review of the data is summarized below.

##### 19.4.2.1 Groundwater

While this site does not have formal COCs for groundwater, LTM of groundwater and surface water is performed to meet RAOs and RCRA closure requirements. Surface and groundwater results for the four metals listed as COCs for soil (arsenic, cadmium, copper, and lead) were reviewed and compared to the screening level, which was based on the lower of the USEPA MCL or the NJGWQS. Based on 2014 and preliminary 3Q and 4Q 2015 groundwater results, 2015 metal concentrations were either lower than or consistent with the baseline events. Concentrations exceeded the site screening level for arsenic by approximately an order of magnitude but are very close to screening levels for cadmium and lead. Lead concentrations in groundwater appear stable or potentially decreasing relative to baseline events conducted in March and April 2014. Select groundwater results are detailed in **Table 19-2**, below.

**Table 19-2: Select Groundwater Monitoring Results**

Metal	Screening Level	2014 Max Baseline		2015			
				3Q Max		4Q Max	
		Result	Well	Result	Well	Result	Well
Arsenic	3	466	1179-2	76.3	1179A-1	39.5	1179A-1
Cadmium	4	6.7	1179D-3	4.7	1179A-2	4.7	1179A-2
Copper	1300	41.7	1179D-3	10	1179D-2	20.2	1179A-1
Lead	5	37.9	1179-4B	7.1	1179-3	11	1179D-2

All concentrations in µg/L

**Exceeds Screening Level**

#### 19.4.2.2 Surface Water

Surface water concentrations adjacent to and downgradient of the Former Lower Burning Grounds do not appear to be affected by COCs in soil beneath the cap, including arsenic, cadmium, copper, and lead relative to concentrations observed in the upgradient surface water monitoring location. Metal concentrations exceeding the surface water screening levels are present at all three locations. Water quality at the GBP is being addressed as a separate site and discussed in **Section 11**. While a temporary increase in surface water concentrations of lead and copper may have occurred in Fall of 2014 adjacent to the Former Lower Burning Grounds during the timeframe of remedy implementation, elevated concentrations were not observed at the downgradient surface water monitoring location at that same time and were not present during the 3Q and 4Q 2015 monitoring events.

### 19.5 Technical Assessment: Site 34

#### 19.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

##### 19.5.1.1 Remedial Action Performance

The primary component of the remedy, the cover, has been installed and the stormwater management system modified to adjust to observed field conditions. Off-site wetlands that were constructed or enhanced as part of the Former Lower Burning Grounds remedial action in 2014 met requirements outlined in the RAWP (ARCADIS, 2014a, b) and documented in the wetlands mitigation construction report (ARCADIS, 2014d).

##### 19.5.1.2 Operations and Maintenance

The remaining components of the remedy include monitoring the groundwater and adjacent surface water in GPB and maintaining and monitoring the constructed wetlands, vegetative and asphalt cover, stormwater controls and LUCs. Groundwater and surface water quality cannot be fully evaluated until an adequate data set is collected and statistical analyses can be performed as outlined in the RAWP.

#### 19.5.1.3 Opportunities for Optimization

As part of the next statistical analyses and optimization of the LTM program, the list of metals (currently 23 metals) should be reviewed for potential reductions. As an example, metals that reflect COCs in the soil or associated with Former Lower Burning Grounds may be retained, while others discontinued. Suggest developing an exit strategy if one has not been previously developed.

#### 19.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified.

#### 19.5.1.5 Implementation of Land Use Controls and Other Measures

LUCs and engineering controls are in place and inspected and certified annually. Review of the 2014 and Internal Draft 2015 Land Use Certification and NFA monitoring reports indicates LUC objectives outlined in the RAWP (ARCADIS, 2014b) are being met.

#### 19.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. As described in **Appendix 4**, SCLs selected in the ROD were compared to current USEPA RSLs for industrial soil and the New Jersey NRDCSCC. Based on the comparison of SCLs in the ROD to RSLs and NRDCSCC, current soil concentrations at the site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

Due to continued site operations at Site 34 (PICA-002) until June 2011, implementation of the remedy included in the 2005 ROD was delayed. During this period of delay between ROD signature and remedy implementation (2014), NJDEP promulgated new SWQSSs. These regulations classified GPB as a C-1 waterway, thus introducing more stringent stormwater and land use regulations at the Former Lower Burning Grounds. While ARARs freeze upon ROD signature, the Army, the USEPA, and the NJDEP decided to comply with new regulations by using a hybrid capping approach that included both soil and asphalt covers. The USEPA determined an ESD was necessary to document the hybrid capping approach and to identify this change as a significant, but not fundamental, change to the selected remedy.

The RAOs remain valid as they eliminate unacceptable risks to on-site workers to the various contaminated media and reduce off-site transport of contaminants via erosion or groundwater migration from surface infiltration. By eliminating unacceptable risks the RAOs ensure the remedy remains protective of human health and the environment.

### 19.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

#### 19.5.3.1 Ecological Risks

No further information on ecological risks has been found that could call the protectiveness of the remedy into question.

#### 19.5.3.2 Natural Disasters

No natural disasters have occurred that could call the protectiveness of the remedy into question.

#### 19.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No new information has been found that could call into question the protectiveness of the remedy.

### 19.5.4 Summary of Technical Assessment

The remedy has been implemented (a reoccurring recommendation from the previous two FYRs) and is operating as intended by the ROD and RD. The primary component of the remedy, the hybrid soil/asphalt cover, has been installed, vegetation established, and the stormwater management system modified to adjust to observed field conditions. LTM of groundwater and surface water has been implemented per the program outlined in the RD. Annual LUC inspections, including inspection of the cover and LUC signs ensure LUCs remain effective at restricting potential exposure to contaminated soils. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or SCLs have occurred which impact the protectiveness of the remedy.

## 19.6 Issues: Site 34

No issues affecting the current or future protectiveness were identified.

## 19.7 Recommendations and Follow-up Actions: Site 34

No recommendations or follow-up actions affecting the current or future protectiveness were identified.

As summarized in **Section 19.5.1.3**, opportunities for optimization of the groundwater and surface water monitoring program may be present.

## 19.8 Protectiveness Statement: Site 34

The remedy for the Former Lower Burning Grounds (PICA-002) is protective of human health and the environment.

The following elements of the remedy have ensured that RAOs are being met. The primary component of the remedy, the hybrid soil/asphalt cover, has been installed, vegetation established, and the

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stormwater management system modified to adjust to observed field conditions. LTM of groundwater and surface water has been implemented per the program outlined in the RD. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections have been conducted to ensure the soil and asphalt cover are maintained, the stormwater management system is functioning as designed, monitoring systems and signs have been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 20.0 RI Concept Plan Site 78 (PICA-013, Site 78)

### 20.1 Background: RI Concept Plan Site 78

Site 78 (PICA-013), located in Area P at Picatinny, is approximately four acres in size (**Figure 20-1**) and encompasses Building 91, a former optics laboratory.

Current land use within Site 78 (PICA-013) is industrial. Building 91 was originally constructed in 1942 as a storehouse and supply building, and contained an optics laboratory in which operations were between 1980 and the mid-1990s. Currently, an office space is located within Building 91 and the building's loading docks still receive materials, some of which is hazardous. The future land uses planned at Site 78 (PICA-013) will ultimately remain as industrial as specified in the most recent Master Plan for Picatinny Arsenal.

Environmental impacts at Site 78 (PICA-013) are associated with historical activities conducted at Building 91, located on Fourth Avenue. Previous investigations have delineated a localized, low-level plume of VOCs in the shallow unconfined aquifer. The source of the VOCs is unknown but is likely attributable to a small-scale discharge at the site.

#### 20.1.1 Site Chronology

**Table 20-1: Chronology of Site Events at RI Concept Plan Site 78**

Event	Date
NJDEP Acceptance of Closure Plan for Building 91	1992
Underground Storage Tank Removal	1999
Performance of Sodium Lactate Groundwater Pilot Study	2004
Final Remedial Investigation Report	2005
Regulatory Submittal of Sodium Lactate Groundwater Pilot Study Report	2005
Final Feasibility Study Site 78 (PICA-013) Report	2009
Draft Final Vapor Intrusion Evaluation Area P	2010
ROD for Groundwater and Surface Water Site 78	2011
Final Remedial Design for Groundwater and Surface Water	2011
Annual LUC and Monitoring Reports	2011-2015

#### 20.1.2 Basis for Taking Action

Based on the results of previous site investigations, COCs were identified for groundwater and surface water. The COCs in groundwater and surface water include:

- 1,1,1-TCA
- TCE
- *cis*-DCE
- VC

A HHRA was conducted for Site 78 (PICA-013) as part of the RI. Potential risks associated with exposure to chemicals in soil, sediment, groundwater, and surface water were quantified for



current/future industrial/research workers, current/future construction/excavation workers, and on-site youth visitors. In summary, the results of the HHRA and the supplemental groundwater evaluation indicate that under the current conditions at Site 78 (PICA-013), constituents in groundwater do pose an unacceptable risk to human health based on existing cancer risks and exceed applicable drinking water standards.

A BERA was conducted at Site 78 (PICA-013) as part of the RI (Shaw, 2005b). The purpose of the BERA was to evaluate the potential risk to aquatic and terrestrial receptors associated with exposure to chemicals in environmental media under current conditions at each site. Results of the ERAs are summarized in the ROD for Site 78 (PICA-013).

## **20.2 Remedial Actions: RI Concept Plan Site 78**

### **20.2.1 Remedy Selection**

The Final ROD for Site 78 (PICA-013) was signed by the U.S. Army on March 23, 2011 and by the USEPA on July 5, 2011. The RAOs as listed in the ROD for Site 78 (PICA-013) are as follows:

- To prevent human exposure to contaminated groundwater that would cause unacceptable risk over the duration of the RA;
- To achieve the more stringent of the Federal MCLs or NJGWQS for the identified COCs in a reasonable timeframe, thereby restoring groundwater to its beneficial use as a drinking water source; and
- To maintain current land-use (industrial) and current ICs at Site 78 (PICA-013).

The selected RA for groundwater at Site 78 (PICA-013) consists of the implementation of MNA and LUCs. The LUCs were selected to eliminate potential exposure to site contaminants. Surface water monitoring will be conducted in conjunction with the long-term groundwater monitoring for the duration of the selected groundwater remedy.

Exposure via the vapor intrusion pathway for an industrial worker within Building 91 was not explicitly evaluated during the HHRA. However, the vapor intrusion pathway at Building 91 was subsequently evaluated through sub-slab soil gas sampling conducted in December 2010. The results were below the conservative, health-based soil gas screening levels, and no further action is required in regard to the vapor intrusion pathway at Building 91.

### **20.2.2 Remedy Implementation**

As stated in the ROD (U.S. Army 2011), the selected RA for groundwater is MNA. The MNA groundwater remedy, established in the Final RD (ARCADIS 2011) for Site 78 (PICA-013) requires groundwater and surface water monitoring on the following schedule:

- Quarterly for the first 2 years of remedy implementation
- Semi-annually for the following 3 years of remedy implementation

- Annually thereafter

Sample locations are shown on **Figure 20-2**. Subsequent to the final (eighth) quarterly sampling event conducted in the second quarter of 2012, groundwater and surface water sampling was decreased to a semi-annual frequency 2012 through 2014 and transitioned to an annual frequency beginning in 2015.

**Section 4.5.2** discusses LUCs utilized at Picatinny and **Section 4.5.3** discusses the facility-wide CEA restrictions which are applicable at this site. The objectives of the LUC were to prevent access or use of the groundwater and surface water until cleanup levels are met, prevent VI of plume vapors within future buildings, maintain the integrity of the monitoring system, maintain the facility-wide CEA, and prohibit excavation below the water table at the site without proper safeguards.

### **20.3 Progress Since Last Five-Year Review: RI Concept Plan Site 78**

Site 78 (PICA-013) was not included in the fourth FYR. At the time, the ROD for Site 78 (PICA-013) had not been approved. Subsequent to the fourth FYR, the ROD was submitted and approved, and the remedial action, MNA, has been implemented at the Site 78 (PICA-079). Annual inspections and LUC certification for 2011 through 2014 have been completed.

### **20.4 Document and Data Review: RI Concept Plan Site 78**

#### **20.4.1 Document Review**

Relevant and appropriate documents associated with the Site 78 (PICA-013) investigations, remedy development, and operations were reviewed for this FYR. Key documents reviewed included:

ARCADIS U.S., Inc. (ARCADIS), 2010. Draft Final Vapor Intrusion Evaluation Area P – Site 78 (PICA-013) Building 91 U.S. Army Garrison Picatinny Arsenal, New Jersey December 2010.

ARCADIS, 2011. Final Remedial Design for Groundwater and Surface Water, Area P – Site 78. U.S. Army Garrison Picatinny Arsenal, New Jersey. August.

ARCADIS, 2014. 2013 Annual Monitoring Report Site 78 (PICA-013) Groundwater and Surface Water U.S. Army Garrison Picatinny Arsenal, New Jersey January 2014

ARCADIS, 2014. 2014 Annual Monitoring Report Site 78 (PICA-013) Groundwater and Surface Water U.S. Army Garrison Picatinny Arsenal, New Jersey October 2014.

EA Engineering Science and Technology (EA). 2015. Internal Draft 2015 Annual Monitoring Report, Site 78 (PICA-013). U.S. Army Garrison Picatinny Arsenal, New Jersey. December.

U.S. Army. 2011. Record of Decision for Groundwater and Surface Water Site 78 (PICA-013), Picatinny Arsenal, New Jersey. March 2011. Final.

#### **20.4.2 Data Review and Evaluation**

Eight quarterly monitoring events were conducted between September 2010 and June 2012, before transitioning to semi-annual monitoring events conducted through 2014 with the first annual event conducted in September 2015. Concentrations of 1,1,1-TCA, TCE, and *cis*-DCE have been below their

respective SCLs in all four MNA network wells since November 2013 (**Table 20-2**). The only constituent continuing to exceed its SCL is VC. VC was detected in 78-MW-006 above its SCL of 1.0 µg/L. It is important to note that 78-MW-003 is the historical plume center and that COCs from this location have exhibited a strongly declining trend since the historical maximum concentration for each constituent. 78-MW-006 is located downgradient of 78-MW-003, which was non-detect for all COCs.

## **20.5 Technical Assessment: RI Concept Plan Site 78**

### **20.5.1 Question A**

*Is the remedy functioning as intended by the decision documents?*

Yes.

#### **20.5.1.1 Remedial Action Performance**

As MNA is the remedial action, groundwater monitoring data confirm that current contamination levels are consistent with or below prior site data. Groundwater use that could result in unacceptable risks to human health is controlled through the facility-wide CEA and LUCs discussed in **Section 4.5**.

#### **20.5.1.2 Operations and Maintenance**

LUCs are in place and inspected and certified annually. No deficiencies were noted with the groundwater monitoring wells during the 2014 inspection.

#### **20.5.1.3 Opportunities for Optimization**

Groundwater monitoring data indicate the contaminant levels are decreasing at a rate that the sampling program for this site could be optimized through a MAROS evaluation.

#### **20.5.1.4 Early Indicators of Potential Issues**

There are no early indicators of potential issues. The LUCs and facility-wide CEA have effectively limited potential exposure to contaminants.

#### **20.5.1.5 Implementation of Land Use Controls and Other Measures**

LUCs are in place and inspected and certified annually.

### **20.5.2 Question B**

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure or the protectiveness of the remedy. Cleanup levels selected in the ROD were compared to current USEPA RSLs (USEPA 2015) for tapwater and the New Jersey GWQC. Based on the comparison of SCLs in the ROD to RSLs and the GWQC, groundwater concentrations at the site would not present an unacceptable risk. Therefore,

SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Table 1**.

The RAOs are to prevent human exposure to contaminated groundwater over the duration of the RA and to achieve site cleanup of COCs in a reasonable timeframe. The RAOs remain valid as they do not allow for unacceptable risk to human health until the groundwater cleanup goals are met and maintains the current land use and ICs. The cleanup criteria is the more conservative of Federal MCLs or NJGWQS for COCs, and to be achieved within a reasonable timeframe. Only VC remains above the cleanup goal and there are no indications the RAOs will not be achieved.

#### 20.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

##### 20.5.3.1 Ecological Risks

No additional information has come to light regarding any ecological risks that could call into question the protectiveness of the RA.

##### 20.5.3.2 Natural Disasters

No natural disasters have occurred that could call into question the protectiveness of the remedy.

##### 20.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information has become available that could call into question the protectiveness of the RA.

#### 20.5.4 Summary of Technical Assessment

The remedy has been implemented and is operating as intended by the ROD and RD. The MNA program has been conducted as outlined in the RD. As of the 2015 sampling event, COCs above SCLs are only present at one of the four monitoring wells (VC at 78MW-6) and results from all three surface water sampling locations have been below SCLs in 2014 and 2015. Annual LUC inspections and maintenance of the facility-wide CEA restricting groundwater use ensure LUCs remain effective at restricting potential exposure to contaminated groundwater. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### 20.6 Issues: RI Concept Plan Site 78

No issues affecting the current or future protectiveness were identified.

## **20.7 Recommendations and Follow-up Actions: RI Concept Plan Site 78**

No recommendations or follow-up actions affecting the current or future protectiveness were identified.

## **20.8 Protectiveness Statement: RI Concept Plan Site 78**

The remedy for Site 78 (PICA-013) is protective of human health and the environment.

The components of the remedy have ensured that RAOs are being met. The MNA program has been conducted as outlined in the RD. As of the 2015 sampling event, COCs above SCLs are only present at one of the four monitoring wells (VC at 78MW-6) and results from all three surface water sampling locations have been below SCLs in 2014 and 2015. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring systems has been maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 21.0 Mid-Valley Groundwater (PICA-204)

### 21.1 Background: Mid-Valley Groundwater

The Mid-Valley Study Area at Picatinny Arsenal is located within the central portion of the Installation and includes groundwater beneath Study Areas F, G, H, and L (**Figure 21-1**). These study areas are bounded to the northeast by Picatinny Lake, to the southwest by Area D, to the southeast by the crest of an unnamed ridge in Area L, and to the northwest by the western edge of Area H. The term “Mid-Valley Region” was assigned to designate the entire study area, which included groundwater contamination that crossed Area boundaries. The Mid-Valley Region, or Mid-Valley, incorporated groundwater issues beneath many individual sites into a single unit which were all addressed by the groundwater RA. With the exception of soils containing elevated explosives near Building 1070 (Site 162, PICA-171 and 173) in Area L, soil and/or sediment contamination was addressed under different decision documents. Consistent with agreements made with regulators, the RA for Mid-Valley Groundwater (PICA-204) included responses for groundwater contamination at the Former DRMO (PICA-072) and the Site 5 (PICA- 162) and Site 6 (PICA-052) Shell Burial Areas. A brief description of Areas F-L and groundwater plumes is discussed below.

#### 21.1.1 Area F

Area F is approximately 77 acres in size and includes 17 sites. Many of the buildings in this area were originally developed to house propellant manufacturing and testing facilities and are currently inactive. Several of these structures were converted to other uses in recent years, including administrative offices. Two AOCs were identified in the groundwater. Elevated concentrations of explosives and VOCs were detected in groundwater at two sites (Sites 104 and 138).

#### 21.1.2 Area G

Area G encompasses the DRMO Yard and six sites surrounding the DRMO Yard. In general, this area was used for a variety of industrial and storage uses, including: a maintenance shop and service shops, a gasoline station, metallurgy laboratories, and a laundry facility where explosives-contaminated clothing was washed. Several of these operations are no longer conducted in this area.

#### 21.1.3 Area H

Area H, commonly referred to as the Munitions Assembly Area, or the 200 Building Area, contains over 70 buildings grouped into 13 sites. In general, pilot-scale munitions production have occurred in Area H since it was first developed. Armament production was increased during WWI, WWII, and the Korean and Vietnam conflicts. Specific operations in Area H included melt-casting, pressing, loading, machining, stenciling, assembly, and disassembly of explosives and explosive devices. Sites 64 and 131 were areas identified with elevated concentrations of chlorinated VOCs in groundwater.

#### 21.1.4 Area L

Area L consists of several different former explosives production, storage, and testing areas and contains buildings in the 1000, 1300, 1400, and 3100 number series. The three AOCs identified in Area L include: 1) TCE contamination in the groundwater at Sites 161 and 18, with elevated concentrations in downgradient wells, 2) elevated levels of RDX at Site 17, and 3) TCE and PCE groundwater

exceedances at Sites 6 and 18. Historical operations, such as presumed sporadic disposal of degreasing solvents associated with Building 3109, and operations at Building 241, are the likely source of two groundwater plumes (the Robinson Run and western VOC plumes, respectively).

Elevated concentrations of RDX and nitrocellulose were detected in soils around former Building 1071 during the RI; these elevated concentrations were associated with parts of a wastewater conveyance system including a concrete sump and pit and former filter box located near Building 1071. Removal actions were completed in this area in 2003 – 2004 in association with the Sump and Dry Well Investigation (Shaw Environmental Inc. [Shaw], 2005). Post-excavation soil data indicated that subsurface RDX contamination extended to the bedrock below the former catch tank and remained elevated in the site soil in particular areas around the former wastewater conveyance system.

The Sites 5 and 6 Shell Burial Areas are also located in Area L. The Shell Burial Areas consist of three former explosion craters that were filled with approximately 25 tons of munitions debris released during the 1926 Naval Ammunition Depot explosion. The Navy continued to use these pits for disposal of material up until 1945, after which the craters were reportedly backfilled with as much as 20 feet of fill material.

#### 21.1.5 Physical Characteristics

A depiction of the Picatinny CSM with the Mid-Valley identified is presented on **Figure 21-2**. The unconfined/weathered bedrock aquifer occurs at the surface in the Mid-Valley Region but is absent on the ridges where granitic/gneissic bedrock with relatively few fractures is exposed at the surface. On the ridge flanks near Robinson Run, the unconfined/weathered bedrock aquifer is composed of weathered and highly fractured bedrock, overlaying competent bedrock. Farther downslope in the glacial sediments of Green Pond Valley, the unconfined/weathered bedrock aquifer is at the surface and composed of unconsolidated glacial sediments, underlain by the upper and lower semiconfined aquifers. As the unconsolidated sediments become thinner on the sides of the valley, the glacial aquifers pinch out. In general, groundwater in the unconfined/weathered bedrock and bedrock flows down the ridge slopes towards Green Pond Brook (GPB) and then flows down-valley. Within the immediate vicinity of Robinson Run groundwater in the shallow bedrock discharges to the Run. Groundwater flow in the lower semi-confined aquifer under static, natural conditions is also towards the center of the valley and then down-valley.

##### 21.1.5.1 Geologic Characterization

A brief discussion of geologic characteristics within the source area and downgradient portion of the Robinson Run VOC plume is necessary to understand chemical fate and transport and injection design. The following is a summary of pre-design geologic characterization from Section 1.3.5 of the RD (ARCADIS, 2013). The Robinson Run VOC plume is divided into three hydrogeological zones with the following characteristics (**Figure 21-3**):

##### Zone 1 – Hot Spot Bedrock:

- Consists primarily of quartz-plagioclase gneiss, consistent with regional geologic mapping.
- Includes area with highest COC concentrations and includes an *in-situ* treatment system

- Fractured bedrock beneath the Site (including Zone 3) likely behaves as a dual-porosity medium in terms of groundwater flow and chemical transport. The key dual-porosity parameters that govern groundwater flow and transport include primary or immobile porosity (i.e., matrix porosity) and secondary or mobile porosity (i.e., fracture porosity).
  - *Bedrock Matrix* has low permeability from a groundwater flow perspective, but can store significant quantities of groundwater and chemicals within its primary or immobile porosity compared with the amount of groundwater and chemicals stored in the fracture network. It has an estimate average porosity of 1.9%.
  - *Bedrock Fracture System* - Groundwater flow is limited to bedrock fractures which provide the primary pathways for flow and transport, but very little storage capacity. It has an estimate average porosity of 0.01%, two orders of magnitude lower than the bedrock matrix.
- Hydraulic Conductivity:
  - Relatively high fracture spacing (approximately 5 to 7 ft)
  - Relatively low bulk permeability (approximately 0.14 ft/day)

#### Zone 2 - Weathered Bedrock:

- Approximately 25 ft of upper bedrock in the central and downstream portions of the Robinson Run valley
- Highly weathered and contains a much greater number of fractures than the competent rock in Zone 1.
- The weathered bedrock lies below the water table and is more strongly chemically altered than in the upgradient hot-spot area (Zone 1).
- Hydraulic conductivity:
  - High degree of weathering and fractures
  - Highest bulk permeability (approximately 6.9 ft/day)
  - Behaves similar to a porous media due to high number of fractures

#### Zone 3 - Downgradient Bedrock:

- Below Zone 2 and beginning at approximately 25 to 35 ft bgs,
- Increasingly competent and contains a moderate degree of fractures
- Hydraulic Conductivity:
  - Relatively low fracture spacing (approximately 2 to 3 ft)
  - Relatively high bulk permeability (approximately 5.9 ft/day)

#### 21.1.6 VOC Plumes

Three VOC plumes have been documented in the Mid-Valley Region: the Robinson Run VOC plume, the northern VOC plume, and the western VOC plume (**Figure 21-4**).

The Robinson Run VOC plume is approximately 5,000 ft long and approximately 600 to 800 ft wide and is present in both the unconfined/weathered bedrock and bedrock aquifer. It appears to be associated with historical site operations at Building 3109 that resulted in a zone of TCE groundwater concentrations greater than 1 µg/L. The area with greater than 1 µg/L is approximately 200 ft long, 100 ft wide, and 50 ft in vertical extent, starting at approximately 60 ft bgs. The TCE was likely released at



the ground surface and migrated down to the water table, which was probably much lower during the 1970s and 1980s than it is now due to historical extensive mine dewatering activities at the nearby Mount Hope Mine. The Mount Hope Mine was dewatered at rates greater than 400 gallons per minute with a potentiometric (water table) drawdown likely greater than 1,000 feet continuously during the approximate period from 1930 to 1980 (Sweet, 1932; Ironminors.com, 2011). Dewatering operations at the Mount Hope Mine could have significantly affected the hydraulic gradients beneath Building 3109 including dropping the water table elevation and possibly inducing a component of flow to the northeast. The TCE became trapped within the low-permeability bedrock. Subsequent rising of the water table after approximately 1980 when dewatering operations ceased at the Mount Hope Mine could have further enhanced the entrapment of TCE within the low-permeability source zone. The Robinson Run VOC plume follows the course of Robinson Run and then turns to the right as it approaches the Mount Hope fault zone. The plume terminates at Green Pond Brook.

The northern VOC plume, with an unknown source, is present in the shallow bedrock and unconfined/weathered bedrock to the north of the Robinson Run plume, where it flows to the west. It is a low concentration plume with TCE concentrations typically around 5 µg/L or less.

The western VOC plume is a low-level plume present in the glacial valley floor (unconfined and lower semi-confined aquifer) to the west of, and flowing southeast toward, GPB. Historical operations at Building 241 are the potential former source of this plume. TCE concentrations are typically 5 µg/L or less.

#### 21.1.7 RDX Plumes

The RDX plume (**Figure 21-4**) is located in the unconfined/weathered bedrock and bedrock aquifer. The plume appears to originate at a bedrock high in the area of Buildings 1071 and/or 1033, which are the potential former sources of the plume. The plume diverges to the west and southwest of the bedrock high. Four soil samples collected during the Remedial Investigation contained RDX concentrations exceeding the LOC of 26 mg/kg in the vicinity of Building 1071, with maximum concentrations of 4,800 mg/kg (qualified as a diluted sample with estimated concentrations) in a surface soil sample and 830 mg/kg (qualified as a diluted sample) in a subsurface soil sample collected between 2.3 and 2.8 ft bgs. Removal actions have occurred in the past at these locations. The maximum groundwater concentration of 80.4 µg/L (well 17MW-5) was limited to a small area of shallow bedrock, and concentrations have been less than 20 µg/L across most of the plume area. RDX has also been detected in the surface waters of Robinson Run, a small tributary to GPB that drains the eastern slope of the valley wall in the vicinity of the Mid-Valley Study Area. Additional source zone soil removal near former Building 1071 was incorporated into the Selected RA in the ROD; however additional characterization conducted in preparation for excavations did not identify soils with concentrations of RDX exceeding the LOC.

#### 21.1.8 Land and Resource Use

For the Mid-Valley Region, the Picatinny Real Property Master Plan (Parsons, 2007) identifies the following land uses: administration, community facilities, maintenance, professional/institutional, open space, and outdoor recreation. Military housing is also present in the area of the Mid-Valley contaminant plumes.

According to the Real Property Master Plan, future land use for the Mid-Valley Region is anticipated to remain consistent with current use. Exceptions include a change in the existing use of property along Buffington Road in Area F from administrative use to community facilities (including construction of a new police station, fire station [already complete], and Child Development Center addition [already complete]), and a slight reconfiguration of the layout of existing land use in the vicinity of Reilly Road in Area H.

#### 21.1.9 Site Chronology

**Table 21-1: Chronology of Site Events at Mid-Valley Groundwater**

Event	Date
Remedial Investigation, various phases and areas	1993-2006
Area L Soil Removal Action near Building 1071	2003-2004
Final Feasibility Study	2009
Pre-Design Investigation and Delineation	2009-2010
Feasibility Study Addendum	2011
ROD signature	2012
Remedy Implementation: ERD Injection and Performance Monitoring Well Installation, Baseline Sample Collection	2012- 2013
First EVO Injection Event	2013
Final Remedial Design	2013
Begin Long-Term Monitoring Program	2013
Second EVO Injection Event	2013
Remedial Action Report	2014
2013-2014 Annual Monitoring Report and Annual LUC Inspections	2014-2015

#### 21.1.10 Initial Response

Remedial investigations resulted in a soil removal action near Building 1071 between 2003 and 2004 in association with the Sump and Dry Well Investigation (Shaw, 2005).

#### 21.1.11 Basis for Taking Action

As part of the RI/FS process, an HHRA and ERA were performed to evaluate the potential risks to human health and the environment associated with exposure to chemicals in Mid-Valley groundwater and surface water. The current use of the Mid-Valley Region area is military/industrial and in limited locations, military/residential. Future use is not anticipated to change. A summary of site risks from the ROD is included below.

Health effects were evaluated for current and reasonably anticipated future industrial/research workers and hypothetical future use of groundwater as a potable water supply by industrial/research workers and residents. For the industrial and residential receptors, routes of exposure evaluated included: ingestion and dermal contact with groundwater, inhalation of VOCs during washroom use or showering, and volatilization of constituents from *in-situ* groundwater to indoor air followed by inhalation. Vapor

intrusion studies conducted in 2007 and 2012 also evaluated this pathway empirically. HHRA results for groundwater and surface water are presented in Table 8 of the ROD. The risks associated with industrial and residential exposure scenarios including potable water supply use are above the NCP target risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  and the cumulative HI threshold of 1.

A series of ERAs were performed, as summarized in the ROD. Ecological risk was screened for three contaminants of potential concern (COPCs) to ecological receptors in groundwater (TCE, RDX, and 2,4,6-TNT) by comparing concentrations detected in surface water to ecological LOCs. Concentrations of TCE, RDX, and 2,4,6-TNT in surface water were lower than the ecological LOCs. Additionally, these chemicals were not detected in sediment samples from GPB or Robinson Run. Thus, TCE, RDX, and 2,4,6-TNT in groundwater discharging to surface water are not expected to have adverse effects on aquatic life in Robinson Run. Fieldwork included breeding bird productivity surveys, small mammal population and relative abundance surveys, small mammal rodent sperm analysis, a benthic macroinvertebrate survey, and wetlands assessment using vegetation sampling and analysis. The results of these investigations indicated that further evaluation or remediation specifically for the protection of ecological end points was not warranted. The assessment concluded that the benthic community of Robinson Run does not appear to be at any significant risk from the potential presence of contaminants from Area L sites in the surface water or sediment or from impacts from groundwater contaminants. No unacceptable ecological risk was identified for Mid-Valley Groundwater (PICA-204).

Based on the HHRA, a RA was necessary to restore the groundwater to its beneficial use as a drinking water aquifer and provide protection to human health and the environment. The following COCs or chemicals with comparison criteria were developed:

Groundwater COCs:

- RDX
- PCE
- TCE
- 2,4,6-TNT (DRMO only)
- Arsenic (DRMO only)
- Cadmium (DRMO only)
- Lead (DRMO and Site 5 and 6)
- Sodium (DRMO only)

Surface water chemicals with comparison criteria:

- RDX
- TCE

Soil near Building 1070:

- RDX

Surface water quality within the Green Pond Brook is managed under the Green Pond Brook ROD and discussed in **Section 11**. An SCL for the RDX soil removal action near Building 1071 was assigned based on site-specific, non-residential direct contact criteria provided by NJDEP.

Groundwater use in the Mid-Valley Region is restricted through the NJDEP-approved CEA. While groundwater is extracted from potable water supply wells installed within the Mid-Valley to support PICA-residents and operations, the groundwater is treated on-site prior to distribution. This use is consistent with its current Class IIA designation, which allows for treatment to render the water potable. Monitoring of potable water supply wells has been incorporated into the LUC component of the Mid-Valley remedy.

## **21.2 Remedial Actions: Mid-Valley Groundwater**

### **21.2.1 Remedy Selection**

The Final ROD for Mid-Valley Groundwater (PICA-204) was signed by the U.S. Army on September 25, 2012 and by the USEPA on September 27, 2012. The RAOs as listed in the ROD are as follows:

- To prevent human exposure to contaminated groundwater that would cause unacceptable risk over the duration of the RA,
- To achieve the more stringent of the Federal MCLs or NJGWQS for the identified COCs in a reasonable timeframe, thereby restoring groundwater to its beneficial use as a drinking water source. For RDX, which has no established MCL or NJGWQS, the HAL will be used as the cleanup goal.

In accordance with the ROD (U.S. Army, 2012) for PICA-204, the selected RA for groundwater consists of:

- Enhanced reductive dechlorination (ERD) using injections of EVO for *in-situ* treatment of Robinson Run VOC plume in the vicinity of Building 3109 where the concentration of TCE exceeds 1,000 µg/L
- MNA of downgradient VOC plumes, RDX plume, and groundwater at the Former DRMO Yard (PICA-072)
- A limited soil removal action to address explosives-contaminated soil in the vicinity of former Building 1071, a potential former source of the RDX plume
- Long-term groundwater monitoring for Site 5 (PICA-162) and Site 6 (PICA-052) Shell Burial Areas
- Implementation and maintenance of LUCs for all components of the groundwater plume

As part of the MNA programs, surface water will be monitored for VOCs and RDX until groundwater RAs result in COC concentrations within Robinson Run that are below the New Jersey Surface Water Quality Criteria for VOCs and the HAL for RDX. As part of the LUCs for the VOC and RDX plumes, potable supply well sampling is conducted.

The ROD also states that the anticipated duration of the expedited *in-situ* enhanced bioremediation to comply with chemical SCLs at the VOC plumes are 35 years for the Robinson Run VOC plume, after *in-situ* treatment has been initiated. The MNA program for the northern and western VOC plumes

would comply with SCLs within 20 years and 35 years, respectively. The MNA remedy for the RDX plume will comply with SCLs within 15 years for the unconfined/weathered bedrock aquifer and 35 years for the bedrock aquifer.

Two vapor intrusion studies were conducted in 2007 and 2012 as discussed in the ROD. Sampling occurred at the Picatinny Child Development Center, located in the downgradient portion of the Robinson Run VOC plume and at a subset of the buildings located in the footprint of the Robinson Run and western VOC plumes (residential Buildings 114 and 115, office/administrative Buildings 118, 119, 172, 173, office/industrial Building 3109, and office/industrial Building 1029). The results of these two studies found that the vapor intrusion pathway is incomplete, with no site-related constituents detected in any sub-slab soil gas or indoor air samples collected. As part of the LUC program outlined in the ROD and RD, LUC objectives include a contingency for vapor intrusion sampling if current land use changes to residential and if any building located above the plume becomes occupied during the remedial action for groundwater.

**Section 4.5.2** discusses LUCs utilized at Picatinny and **Section 4.5.3** discusses the facility-wide CEA restrictions which are applicable at this site. The LUCs were selected to eliminate potential exposure to site contaminants.

#### 21.2.2 Remedy Implementation

The injection wells and ERD performance monitoring wells were installed from November 2012 through March 2013. Three types of injection wells were installed in the ERD area: 1) shallow “hot spot” injection wells, 2) shallow downgradient injection wells, and 3) deep downgradient injection wells. The 18 injection wells are organized into three transects oriented perpendicular to groundwater flow, as shown on **Figure 21-5**. The vertical extent of injection well construction relative to the Robinson Run VOC plume is shown on **Figure 21-3**. Based on the RD, a radius of influence of 15 ft was targeted for the injections, and injection wells were spaced at approximately 30 feet on center. Eight new performance monitoring wells were installed within the design radius of influence of the injection wells and two performance wells (1171MW-13 and 13B) were installed downgradient of the injection zone, as shown on **Figure 21-5**.

Baseline groundwater and surface water sampling for all Mid-Valley monitoring programs took place between February and June 2013. The detailed monitoring programs, networks established in the RD, are presented in **Tables 21-3** and **21-4** and on **Figures 21-6, 7, and 8**. A summary of the monitoring programs and associated Tables and Figures with detailed information is presented in **Table 21-2** below.

**Table 21-2: Monitoring Program Summary**

Monitoring Program	Program	Basis for Monitoring	Table	Figure
ERD Performance Network	Performance	VOCs	Table 21-3 Table 21-4	Figure 21-5 Figure 21-6
VOC Plumes (Robinson Run, Western, and Northern)	MNA	VOCs	Table 21-3 Table 21-4	Figure 21-6
RDX Plume	MNA	Explosives	Table 21-3 Table 21-4	Figure 21-7
DRMO Yard	MNA	Explosives and Metals	Table 21-3 Table 21-4	Figure 21-7

Monitoring Program	Program	Basis for Monitoring	Table	Figure
Site 5 and 6	LTM	VOCs, Explosives, Metals	Table 21-3 Table 21-4	Figure 21-8
Potable Water	LUCs	VOCs, Explosives	Table 21-3 Table 21-4	Figure 21-6 Figure 21-7
Surface Water (part of MNA programs)	MNA	VOCs, Explosives	Table 21-3 Table 21-4	Figure 21-6 Figure 21-7

#### 21.2.2.1 Site 162 (near Building 1071) Soils Characterization

In June 2013, sampling and analysis of soils for explosives were completed to characterize the current conditions at Site 162 near former Building 1071, believed to be the source of the RDX groundwater plume. The investigation was conducted in preparation for planned source removal. RDX was not detected above the SCL of 26 mg/kg. Therefore a removal action was not performed. MNA will be used for remediation of the RDX plume in accordance with ROD.

#### 21.2.3 Systems Operations / O&M Requirements

##### 21.2.3.1 ERD via Injection of EVO

Injections of EVO, a carbon substrate, have been performed in shallow and deep bedrock wells in the Robinson Run VOC plume near Building 3109 where the TCE concentration is greater than 1.0 µg/L. An injection and performance monitoring network (**Figures 21-5** and **21-6**) was installed between December 2012 and March 2013. The first and second EVO injection events were conducted in March and December 2013. A summary of injection wells and volumes is presented in **Table 21-5**, below. Following injection of the carbon solution, a clean water flush was conducted. In most cases, the volume of clean water was similar to the injection volume and is summarized in Table 3 of the 2013 Annual Report (ARCADIS, 2013). The ERD performance monitoring network includes 17 monitoring wells and four injection wells sampled for VOCs, DOC, dissolved gases (methane, ethene, and ethane), and iron in select wells. Performance monitoring results are used to determine when future injections are necessary and if adjustments to the injection program are needed (volumes, carbon concentration, type of EVO, injection methodology, etc.). The injection philosophy laid out in the RD relies on adaptive design principles which encourage modification of the injection program in response to field observations.

If concentrations within the active ERD area decrease and are maintained at levels below those found in the diffuse plume as determined through statistical analyses, a reduction in injection frequency or temporary suspension of injections may be implemented.

**Table 21-5: Injection Volume Summary**

Injection Transect	IWs	IW Depth (ft bgs)	Volume of 1% EVO March 2013	Volume of 1% EVO December 2013
1st injection line (High Concentration ERD Area)	171IW-001 – 003	38-120	530 Avg/IW:176	538 Avg/IW:177

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Injection Transect	IWs	IW Depth (ft bgs)	Volume of 1% EVO March 2013	Volume of 1% EVO December 2013
2nd injection line (High Concentration ERD Area)	171IW-004 – 006	28-120	400 Avg/IW:133	523 Avg/IW:174
3rd injection line - shallow (13th St ERD Area)	17IW007S- 012S	20-90	1196 Avg/IW:199	1186 Avg/IW:198
3rd injection line - deep (13th St ERD Area)	17IW007D- 012D	90-190	866 Avg/IW:144	831 Avg/IW:139
Total	18		3,122	3,076

**Notes:**

IW = injection well

Avg/IW = average per injection well

Volume in gallons

#### 21.2.3.2 MNA and LTM Programs

Since remedy implementation in 2013, groundwater monitoring activities including MNA and long term groundwater monitoring program detailed in **Section 21.1.2** have been conducted in accordance with RD and documented in the 2013 and 2014 Annual Monitoring Reports.

As part of the MNA programs, surface water has been monitored for VOCs and RDX at five locations within Robinson Run and at a tributary of Green Brook Pond. Sampling has been consistent with programs outlined in the RD.

#### 21.2.3.3 LUCs and Potable Water Monitoring

LUCs were implemented in 2013 to control current and future activities that could cause exposure to environmental contaminants resulting in unacceptable risk to human health. LUC objectives are documented in the RD and tracked through annual inspections and land use certification reporting. Annual LUC inspections and certifications for Mid-Valley were conducted annually from 2013 through 2015. The LUC reports certify that the objectives outlined in the LUC Plan included in the RD (ARCADIS, 2013) are being met.

As part of the LUC program, in the event land use at Mid-Valley changes to a more active industrial or non-industrial use, implementation of vapor intrusion sampling will occur within any building located above the plume that becomes occupied during the remedial action for groundwater.

Potable supply well sampling is conducted under the LUC program for Mid-Valley, as shown in **Table 21-2**. The groundwater underlying the Mid-Valley Region is part of the facility-wide CEA, discussed in **Section 4.5.3** which restricts groundwater use.

### 21.3 Progress Since Last Five-Year Review: Mid-Valley Groundwater

The Mid-Valley Groundwater (PICA-204) remedy was not included in the fourth FYR. Since the 2011 FYR, the ROD has been signed, RD completed, and the RA implemented. Two annual monitoring reports have been produced since remedy implementation.

## 21.4 Document and Data Review: Mid-Valley Groundwater

### 21.4.1 Document Review

Relevant and appropriate documents associated with the Mid-Valley Groundwater remedy selection, implementation, and O&M were reviewed for this fifth FYR. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

ARCADIS 2008. Vapor Intrusion Sampling for the Child Development Center – September 2007. March.

ARCADIS 2010. Source Area Pre-Design Monitoring Well Installation Work Plan Mid-Valley Groundwater (PICA-204). March.

ARCADIS 2012. Final Vapor Intrusion Report Mid-Valley Groundwater (PICA-204). June.

ARCADIS, 2013. Final Remedial Design Mid-Valley Groundwater (PICA-204). March.

ARCADIS, 2014a. Final Remedial Action Report Mid-Valley Groundwater (PICA-204). May.

ARCADIS, 2014b. 2013 Annual Monitoring Report Mid-Valley Groundwater (PICA-204). May.

ARCADIS, 2014c. 2014 Annual Monitoring Report Mid-Valley Groundwater (PICA-204). November.

Ironminors.com, 2011. Mount Hope Mine. The Iron Miners are a group of miners and historians dedicated to capturing and preserving historic abandoned mines in the United States. <http://www.ironminers.com>. Last accessed April 28, 2011.

New Jersey Geologic Survey, 2011. Interpretation of Borehole Televiewer Data and Hydrogeologic Framework for the Picatinny Arsenal Mid-Valley Groundwater Investigation.

Shaw 2005<sup>4</sup>. Report on the Investigation of Sumps and Dry Wells with Previously Identified COCs at Various Sites (Draft Final). Prepared for U.S. Army Corps of Engineers – Baltimore District. Contract No. DACA-31-95-D-0083. June.

Sweet, J.R. 1932. Mining Methods and Costs at the Mount Hope Mine of the Warren Foundry and Pipe Corporation, Mount Hope, NJ. United States Bureau of Mines. Department of Commerce. Information Circular. April, 1932.

Robinson, Barry, McCarty, Gerhard, and Kouznetsova, 2009. pH Control for Enhanced Reductive Bioremediation of Chlorinated Solvent Source Zones. *Science of the Total Environment*. March.

U.S. Army, 2012. Record of Decision, Mid-Valley Groundwater (PICA-204) – Picatinny Arsenal, New Jersey. September.

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<sup>4</sup> Document was included as a reference but was not reviewed.  
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## 21.4.2 Data Review and Evaluation

### 21.4.2.1 ERD Performance Monitoring

The ERD performance monitoring charts and groundwater and surface water concentration charts provided in **Appendix D** and **Appendix E**, respectively of the 2014 Annual Report (ARCADIS, 2014c) were reviewed in addition to the 3Q 2015 preliminary data set.

#### Solution Distribution and Carbon Longevity

ERD effectiveness, like other *in-situ* remedies, is often limited by the ability to distribute reagent or carbon solution into the treatment zone. As summarized in **Section 21.1.5**, the bedrock behaves as a dual-porosity system, with the mobile porosity estimated at 0.01% and immobile porosity estimated at 1.9%. The high fracture spacing (5 to 7 ft) and low bulk permeability (0.14 ft/day) complicates ERD monitoring relative to a system installed in a porous medium. Arrival of solution in performance monitoring wells is a function of the interconnection between the injection wells and the performance monitoring wells via the bedrock fracture system or mobile porosity, which may be erratic. Based on the summary of DOC concentrations at monitoring wells located within the design ROI of 15 ft in **Table 21-6**, carbon distribution above baseline was irregular and lower than traditionally observed in porous media. In many cases, distribution appeared to improve after the second injection event. Because EVO contains a soluble component (e.g., lactate) and a lower solubility emulsified oil, transient increases in DOC observed in many wells are likely associated lactate and not the EVO. In ROI wells where both carbon components of the EVO are present, DOC attenuation can be reviewed in tandem with other performance monitoring parameters to adjust injection frequency. The frequency of injections may also change over time as the IRZ becomes established. Based on the limited DOC present as of 3Q 2015 and relatively low historical maximum concentrations of DOC, an injection event is recommended during 2016. The RD sets forth the criterion, “if DOC concentrations fall below 100 mg/L in one or more injection wells, an additional EVO injection will be considered” (ARCADIS, 2013). Injection frequency will be evaluated as part of the 2015 Annual Report which was unavailable for this FYR. The levers used to improve distribution include, increasing or reevaluating injection volumes, increasing carbon concentration, and carbon substrate selection. Given the challenges associated secondary porosity-driven transport and the principles of adaptive design espoused in the RD, future injection events should consider increasing volumes to injection wells that appear more hydraulically connected to the treatment zone. A volume to radius relationship could be reevaluated during the next injection event to understand relative benefit associated with increasing injection volumes.

**Table 21-6: Dissolved Organic Carbon Distribution**

Location	Well ID	Unit	Screened Interval (ft bgs)	Dissolved Organic Carbon (mg/L)	
				Historical Max	3Q 2015
1st Line IW	171IW-002	Bedrock	30 - 120	<20	<20
1st Line - ROI	171MW-6	Bedrock	38 - 58	>100	<20
1st Line - ROI	171MW-6B	Bedrock	70 - 90	20-100	<20
1st Line - ROI	171MW-6C	Bedrock	190 - 210	<20	<20
1st Line - ROI	171MW-14	Bedrock	50 - 70	<20	<20
1st Line - ROI	171MW-14B	Bedrock	80 - 100	20-100	<20
2nd Line IW	171IW-005	Bedrock	30 - 120	20-100	<20

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Location	Well ID	Unit	Screened Interval (ft bgs)	Dissolved Organic Carbon (mg/L)	
				Historical Max	3Q 2015
2nd Line ROI	171MW-15	Bedrock	60 - 80	<20	<20
2nd Line ROI	171MW-8	Bedrock	65 - 85	>100	<20
2nd Line ROI	171MW-8B	Bedrock	100 - 120	<20	<20
3rd Line - IW (S)	171IW-010S	Bedrock	20 - 90	>100	<20
3rd Line - IW (D)	171IW-010D	Bedrock	90 - 190	>100	<20
3rd Line ROI	171MW-16	Bedrock	50 - 70	<20	<20
3rd Line ROI	171MW-16B	Bedrock	140 - 160	<20	<20
3rd Line ROI	171MW-17	Bedrock	50 - 70	20-100	<20
3rd Line ROI	171MW-17B	Bedrock	140 - 160	20-100	<20

**Notes:**

IW = Injection Well

Max = Maximum

ROI = Radius of Influence

3Q 2015 is preliminary

<20 mg/L Limited distribution

20-100 mg/L Some distribution

>100 mg/L Good distribution

### Review of pH

The microbial community being stimulated and particularly the microbes responsible for reductive dechlorination prefer an environment with a pH between 6.5 and 8.5. A sustained pH less than 5 within the ROI or zone of active treatment adversely affects treatment (Robinson et. al, 2009). The ERD trend charts indicate that the naturally occurring pH of the bedrock in the vicinity of injections ranges from 5 to 6. In many cases, an increase in pH is observed after the injection events, potentially due the 1% sodium bicarbonate included in the EVO. The pH generally returned to the baseline levels by the end of 2014, approximately a year after the most recent injection event. During the next injection event, pH should be closely monitored (many chart readings appear anomalous) and the buffering capacity of the injection solution potentially enhanced to determine whether pH can be marginally increased within the ROI.

### Establishment of a Reducing Environment

While contaminant degradation and treatment is limited by distribution, there was evidence that reducing conditions have or were in the process of being established, as supported by increases in methane and a conversion from TCE to degradation products, *cis*-DCE and VC. In some cases, wells with limited DOC (< 20 mg/L) including 171MW-15, 16, and 16B saw significant increases in methane (>0.5 mg/L) and degradation products (>50% *cis*-DCE and VC). A review of ERD data is included in **Table 21-7**. A review of ethene and ethane data was not performed given the low level detections; however these data may be useful in the future.

### Contaminant Reduction and Trends

Given the recent initiation of the injection program in 2013 and the limited post-injection data available at the time of this review, concentration trend charts for wells in the ERD program were visually inspected. A statistical analysis of contaminant trends will be performed in 2016. Trends in total

CVOC mass appear to be generally stable with a few wells showing declines and no obvious increasing trends. Geologic characterization (**Section 21.1.5**) indicates a significant portion of groundwater (and presumably contaminant mass) is stored in the immobile, bedrock matrix. The primary mechanism for mass removal is likely tied to matrix diffusion, a much slower process than physical flushing of the secondary porosity. As a result, additional injection events and monitoring data will be needed before knowing whether and when injections will achieve their goal of reducing COC concentrations below levels observed in the downgradient plume and within the ROD's estimated timeframe of 35 years for the downgradient plume.

#### 21.4.2.2 MNA and LTM Program Data Review

Groundwater and surface water concentration charts provided in Appendix E of the 2014 Annual Report (ARCADIS, 2014c) were reviewed in addition to the 3Q 2015 preliminary data set and 2013 and 2014 isoconcentration maps. The 2015 Annual Report was not available at the time of this FYR. Given the short data record (2013-2014, 3Q 2015 event) and the statistical analysis planned for 2016, trend charts were visually inspected to identify increasing trends, detections in sentinel wells, or anomalous results. Data reported in the annual reports were also reviewed against conclusions presented within the data evaluation section of these reports. As summarized in **Table 21-8**, plumes (when present) were found to be generally stable and 2015 3Q results generally consistent with 2013 and 2014 results documented in the annual monitoring reports.

During this review, it was noted that samples collected from the wellhead of potable water supply D-PW-302D have not been historically analyzed for 1,4-dioxane. While there is no direct evidence that 1,4-dioxane is present in groundwater at Mid-Valley, the next two rounds of sampling at PW-302D should include analysis of 1,4-dioxane, given potential exposure concerns and specialized ex situ treatment needed to treat 1,4-dioxane. This same recommendation was noted for potable water supply well D-PW-131 in Area D, as discussed in **Section 8.0**.

**Table. 21-8: MNA and LTM Program Data Review**

Plume	Unit	Analytes	Question 1	Question 2	Comments
Robinson Run (downgradient plume)	WBR	VOCs	Yes	No	
	Bedrock		Yes	No	
Western VOC	WBR	VOCs	Yes	No	
Northern VOC	WBR	VOCs	Yes	No	
	Bedrock		Yes	No	
RDX Plume	WBR	RDX	Yes	No	
	Bedrock / LSC	RDX	Yes	No	
Former DRMO Yard	WBR	Explosives Metals	Yes	No	No defined plume, consistent with annual reports
	LSC		Yes	No	
Site 5 and 6 Shell Burial	WBR	Explosives, Metals, VOCs	Yes	No	No evidence of release (see Note 1)
	Bedrock		Yes	No	
Surface Water	--	VOCs Explosives	--	No	2015 data not available. See Note 2.

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Plume	Unit	Analytes	Question 1	Question 2	Comments
Potable Water Wells	PW-302D only	VOCs, explosives	Yes	No	Only detection: TCE at 2.0 µg/L, consistent with historical range

**Notes:**

Question 1: 3Q 2015 results consistent with 2013-2014 results?

Question 2: Does visual inspection indicate increasing trends, detections in sentinel wells, or anomalous results?

1 - The purpose of the LTM program for Sites 5 and 6 Shell Burial Areas is to detect evidence of a release of the analyzed parameters from munitions items, drums, and other items potentially buried in these areas.

2 - Of the five surface water monitoring locations, low levels of RDX (2.1 µg/L vs. SCL of 2.0 µg/L) and TCE (4.8 µg/L vs. SCL of 1.0 µg/L) have been identified above the SCL at one location for RDX and three locations for TCE since 2013.

## 21.5 Technical Assessment: Mid-Valley Groundwater

### 21.5.1 Question A

*Is the remedy functioning as intended by the decision documents?*

Yes.

#### 21.5.1.1 Remedial Action Performance

The monitoring and LTM programs implemented in 2013 have functioned as intended by the design documents. Due to recent implementation of the remedy, progress towards meeting the cleanup timeframes presented in the ROD cannot yet be fully evaluated. As summarized in **Table 21-8**, plumes (when present) were found to be generally stable and 2015 3Q results were generally consistent with 2013 and 2014 results documented in the annual monitoring reports. Annual LUC and land use inspections, sampling of potable water supply well PW-302D, and maintenance of the facility-wide CEA restricting groundwater use has been conducted, consistent with the RD. Public awareness of the site and inclusion of the site into the installation GIS has restricted unintentional exposure to groundwater contamination. These LUCs and Picatinny ICs have been effective at restricting potential exposure to contaminated groundwater and surface water.

#### 21.5.1.2 Operations and Maintenance

Consistent with the ROD and RD, injections of EVO have been performed in shallow and deep bedrock wells in the Robinson Run VOC plume near Building 3109 where the TCE concentration is greater than 1.0 µg/L. The first and second EVO injection events were conducted in March and December 2013. While injection frequency is evaluated within the annual reports and the 2015 annual report was unavailable for this FYR, 3Q 2015 data indicated DOC in all ROI wells was below 20 mg/L and near baseline levels in most wells. Another injection event is therefore recommended. ERD performance monitoring results, collected to assess the effectiveness of EVO injections, indicate irregular distribution of carbon and some instances where reducing conditions were established and treatment is occurring. Opportunities for improving injection's effectiveness are discussed in the following section.

### 21.5.1.3 Opportunities for Optimization

Based on the ERD performance review presented in **Section 21.4.2.1**, the following observations may improve IRZ performance:

- DOC in all ROI wells is below 20 mg/L as of 3Q 2015 and near baseline levels in most wells. Another injection event is therefore recommended.
- Improve distribution:
  - Reevaluate the volume to radius relationship during the next injection event to understand relative benefit associated with increasing injection volumes. For example, future injection events should consider increasing volumes to injection wells that appear more hydraulically connected to the treatment zone.
  - Consider increasing the strength of EVO or carbon within the injection solution
- Review whether injection solution buffering capacity can be enhanced to marginally increase the bedrock's naturally low pH (~5 to 6 s.u.) and offset acidic byproducts produced within the IRZ.

### 21.5.1.4 Early Indicators of Potential Issues

No early indicators of potential issues were identified, beyond optimization of the ERD discussed in **Section 21.5.1.2**.

### 21.5.1.5 Implementation of Land Use Controls and Other Measures

Land use controls are in place, consistent with the RD, certified and inspected annually, and have proven effective in preventing exposure until the RAOs are achieved. Concentrations of TCE detected in Mid-Valley potable water supply well PW-302D are consistent with historical results.

## 21.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. There have been no changes in the physical conditions of the site or the land use at Picatinny Arsenal since the Army's last FYR that would affect the routes of exposure and the protectiveness of the remedy. SCLs selected in the ROD were compared to current USEPA RSLs (USEPA 2015) for tapwater and the New Jersey GWQC. Based on the comparison of SCLs in the ROD to RSLs and GWQC, groundwater concentrations at the Site would not present an unacceptable risk. Therefore, SCLs selected in the ROD remain valid. SCLs were also compared to NJDEP ESC to understand whether SCLs remain valid and continue to protect ecological receptors at Picatinny. This evaluation determined that the remedy remains protective of ecological receptors. This comparison is presented in **Appendix 4**.

The conclusions from previous VI studies conducted in 2007, 2008, and 2012 summarized in **Section 21.2.1** were reviewed in the context of current site conditions and found to remain valid. VI study results and previous screening levels were compared against current NJDEP Generic Screening Levels

(March 2013) and current EPA VISLs. Groundwater trends and plume extent were compared to conditions during the previous VI studies. Land use and building occupancy were reviewed for changes and remain consistent with previous assumptions.

The RAOs are to prevent human exposure to contaminated groundwater over the duration of the RA and to achieve site cleanup of COCs in a reasonable timeframe. The RAOs remain valid as they do not allow for unacceptable risk to human health until the groundwater cleanup goals are met. The cleanup criteria is the more conservative of Federal MCLs or NJGWQS for COCs (the HAL will be used for RDX), and to be achieved within a reasonable timeframe. The remedy is in the early stage of treatment and additional data will be necessary to determine if the RAOs will be met, however none of the data collected so far indicate the RAOs will not be achieved.

#### 21.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

##### 21.5.3.1 Ecological Risks

No information on ecological risks has come to light that could call the protectiveness of the remedy into question.

##### 21.5.3.2 Natural Disasters

No natural disasters have occurred that could call the protectiveness of the remedy into question.

##### 21.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information has come to light that could call the protectiveness of the remedy into question.

#### 21.5.4 Summary of Technical Assessment

The remedy has been implemented and is operating as intended by the ROD and RD. Performance monitoring results collected to assess the effectiveness of EVO injections, indicate irregular distribution of carbon and some instances where reducing conditions were established and treatment is occurring. Opportunities for optimizing the injections have been provided in **Section 21.5.3.1**. MNA groundwater trends and results associated with the VOC and RDX plumes as well as the LTM programs were found to be generally stable or consistent with previous results. Progress towards meeting the cleanup timeframes presented in the ROD cannot yet be fully evaluated due to recent implementation of the remedy. Performance and groundwater and surface water monitoring have been completed, consistent with the RD. Annual LUC inspections, sampling of potable water supply well PW-302D, and maintenance of the facility-wide CEA restricting groundwater use ensures LUCs remain effective at restricting potential exposure to contaminated groundwater and surface water. None of the LUC inspection results have identified an issue which would impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

## **21.6 Issues: Mid-Valley Groundwater**

No issues have been identified that affect the current and/or future protectiveness.

## **21.7 Recommendations and Follow-up Actions: Mid-Valley Groundwater**

No recommendations or follow-up actions were identified that affect the protectiveness of the remedy

### **21.7.1 Other Recommendations and Findings**

During the next two regularly scheduled sampling events, samples collected from the wellhead of potable water supply well PW-302D should be analyzed for 1,4-dioxane. During the next annual sampling event, a subset of monitoring wells shall be analyzed for perchlorate and reported in the annual report. The subset will include monitoring wells along the longitudinal axis of the plume and/or wells representing the areas with highest concentrations of explosives, a few locations downgradient, and the locations where perchlorate was historically detected as summarized in the 2005 FS. In 2000, Mid-Valley groundwater was sampled for perchlorate. These results indicated that two of the 14 samples analyzed for perchlorate exceeded the screening criteria, and these locations were isolated to Site 142 in Area F. Samples collected from potable water supply well PW-302D located within Mid-Valley were analyzed for perchlorate in 2002, 2004, 2005, and 2009. These results were non-detect (<0.2 ug/L in 2009).

As discussed in **Section 21.5.1.2**, opportunities were identified that may support optimization of the ERD injection program.

## **21.8 Protectiveness Statement: Mid-Valley Groundwater**

The remedy for Mid-Valley Groundwater (PICA-204) is protective of human health and the environment.

The components of the remedy have ensured that RAOs are being met. Performance and groundwater and surface water monitoring have been completed, consistent with the RD. MNA groundwater trends and results associated with the VOC and RDX plumes as well as the LTM programs were found to be generally stable or consistent with previous results. ERD injections have been conducted, consistent with the RD; performance monitoring results show some instances where reducing conditions were established and treatment is occurring but also highlight areas where optimization may improve the effectiveness of injections. The facility-wide CEA restricts access to and use of groundwater at PICA. Annual LUC inspections ensure the integrity of monitoring and injection networks and signs are maintained, no unauthorized intrusive activities have occurred, and land use remains unchanged. ICs enforced by the Army, such as access restrictions, land use restrictions, and soil disturbance procedures remain active and effective.

## 22.0 25 Site Group (multiple sites)

### 22.1 Background: 25 Site Group

The 25 Site Group, addressed the remedies at 26 sites located in four areas at Picatinny (**Figure 22-1** through **Figure 22-25**). All but one site was determined to require NFA with monitoring of land use to ensure the land use remains military/industrial. Site 113 (PICA-146) was determined to require NFA and could be released for unrestricted exposure. The 25 Site Group, separated by area, consists of the following:

- Area D - Site 189 (**Figure 22-1**)
- Area I - Site 16 (**Figure 22-2**), Site 32 (**Figure 22-3**), Site 33 (**Figure 22-4**), Site 46 (**Figure 22-5**), Site 50 (**Figure 22-6**), Site 63/65 (**Figure 22-7**), Site 97 (**Figure 22-8**), Site 105 (**Figure 22-9**), Site 108 (**Figure 22-10**), Site 113, Site 147 (**Figure 22-11**), Site 148 (**Figure 22-12**), Site 150 (**Figure 22-13**), Site 184 (**Figure 22-14**)
- Area K - Site 199 (**Figure 22-15**)
- Area L - Site 17 (**Figure 22-16**), Site 18 (**Figure 22-17**), Site 35 (**Figure 22-18**), Site 91 (**Figure 22-19**), Site 161 (**Figure 22-20**), Site 162 (**Figure 22-21**), Site 166 (**Figure 22-22**), Site 168 (**Figure 22-23**), Site 169 (**Figure 22-24**), Site 171 (**Figure 22-25**)

The 25 Site Group has been used for military and industrial purposes. The future land uses planned for most the 25 Site Group will ultimately remain as industrial as specified in the most recent Master Plan for Picatinny Arsenal. Sites 16, 46, 97, 105, 113, 148, 166, 168, and 189 were determined to have no suspected groundwater sources or had no exceedances of groundwater drinking water standards.

Descriptions of each of the 25 Site Group sites are included in **Appendix 5**.

#### 22.1.1 Site Chronology

**Table 22-1: Chronology of Site Events at 25 Site Group**

Event	Date
Preliminary Assessments/Site Investigations	1988-1998
Remedial Investigations	1994-2003
Additional sampling, focused remedial actions	1990-2005
Feasibility Study	2009-2012
Record of Decision	2014

#### 22.1.2 Basis for Taking Action

Based on the results of previous site investigations, contaminants were evaluated only for the current and reasonably anticipated future use. An HHRA for the sites included exposure scenarios for the current outdoor maintenance workers, future industry/research workers, and future construction/excavation workers based on site specific concentrations of contaminants which exceeded



comparison criteria. Additional qualitative risk evaluations were conducted at some sites at the request of the USEPA to determine if site conditions met the requirements of unrestricted use using current LOCs because either only qualitative risk evaluations were conducted previously or because some data were not included in the previous quantitative risk evaluation due to the availability of more recently collected data. The results of the risk assessment indicated that under the current and hypothetical exposure scenarios, the excess lifetime carcinogenic risk posed by contaminants was within the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  and the HI is below 1 for the current land use at each of the 25 sites. As discussed in **Section 4.6**, the Army chose to develop a remedial action for the sites based on the  $1 \times 10^{-6}$  risk level due to a specific request by the USEPA and the NJDEP to consider a remedial action at these sites.

The concentrations of contaminants at each site which exceeded the LOC can be found on the figures for each site (**Figure 22-1** through **Figure 22-25**).

## **22.2 Remedial Actions: 25 Site Group**

### **22.2.1 Remedy Selection**

The ROD for the 25 Site Group was signed by the U.S. Army and the USEPA in 2014. The selected RA for Sites 16, 17, 18, 32, 33, 35, 46, 50, 63/65, 91, 97, 105, 108, 113, 147, 148, 150, 161, 162, 166, 168, 169, 171, 184, 189, and 199 was NFA with annual monitoring of land use. Site 113 was also determined to be NFA and could be released for unrestricted use.

Sites 16, 46, 97, 105, 113, 148, 166, 168, and 189 were determined to have no suspected groundwater sources or had no exceedances of groundwater drinking water standards. The groundwater concerns for Sites 17, 18, 35, 161, 162, and 171 are being addressed under the Mid-Valley Groundwater Site (PICA-013) discussed in **Section 21** of this report.

Sites 33, 50, 63/65, 91, 108, 147, 150, 184, and 199 have minor, isolated concentrations of various constituents that exceed groundwater drinking water standards. The groundwater concerns at these sites are addressed through the facility-wide CEA LUC at Picatinny. See **Section 4.5.3** of this report for further discussion on the Picatinny CEA.

### **22.2.2 Remedy Implementation**

All of the sites in the 25 Site Group were determined to require NFA. Annual inspections occur to verify land use has not changed from military/industrial.

## **22.3 Progress Since Last Five-Year Review: 25 Site Group**

This is the first FYR since the 25 Site Group ROD was signed; therefore, no recommendations, issues, or protectiveness statements were made.

Subsequent to the fourth FYR, the Proposed Plan and ROD were submitted and approved by the USEPA. The ROD selected a NFA RA for all of the sites in the 25 Site Group with annual monitoring of land use for all but Site 113. One land use inspection has occurred since the 2014 ROD was signed.

## **22.4 Document and Data Review: 25 Site Group**

### **22.4.1 Document Review**

Relevant and appropriate documents associated with the 25 Site Group investigations, remedy development, and operations were reviewed for this fifth FYR report. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

U.S. Army, 2013. Final Proposed Plan for 25 Picatinny Sites. February.

U.S. Army, 2014b. Final No Further Action with Monitoring of Land Use Record of Decision for 25 Site Group. March.

### **22.4.2 Data Review and Evaluation**

Chemical data are not collected as part of the remedy at the 25 Site Group. Annual inspections are conducted to verify no changes in land use have occurred.

## **22.5 Technical Assessment: 25 Site Group**

### **22.5.1 Question A**

*Is the remedy functioning as intended by the decision documents?*

Yes.

#### **22.5.1.1 Remedial Action Performance**

The selected remedy for the 25 Site Group is NFA for all 26 sites with Site Monitoring for 25 of the sites. The 2015 inspection has occurred and verified no changes in land use have occurred. The selected remedy is functioning as intended by the 2014 ROD.

#### **22.5.1.2 Operations and Maintenance**

Annual inspections are only required to document the land use, no further maintenance is required at the sites.

#### **22.5.1.3 Opportunities for Optimization**

No opportunities for optimization were identified during this FYR.

#### **22.5.1.4 Early Indicators of Potential Issues**

No early indicators of potential issues were identified during this FYR.

#### **22.5.1.5 Implementation of Land Use Controls and Other Measures**

The 25 Site Group was determined to require NFA at all sites; LUCs were not a part of the selected remedy. The annual inspections performed document the land use has not differed from what was assumed in the ROD.

#### 22.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. The 25 Site Group was determined to require NFA at all sites; LUCs were not a part of the selected remedy and no RAOs were formalized in the ROD. All of the sites within the 25 Site Group require annual documentation showing the land use has not changed from what was assumed in the ROD. The annual inspections have documented the land use has not differed from what was assumed in the ROD. The exposure assumptions, toxicity data, and RAOs remain valid because the land use has not changed at the sites.

#### 22.5.3 Question C

*Has any other information come to light that could call into question the protectiveness of the remedy?*

No.

##### 22.5.3.1 Ecological Risks

No information on ecological risks has come to light that could call the protectiveness of the remedy into question.

##### 22.5.3.2 Natural Disasters

No natural disasters have occurred that could call the protectiveness of the remedy into question.

##### 22.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information has come to light that could call the protectiveness of the remedy into question.

#### 22.5.4 Summary of Technical Assessment

All of the sites within the 25 Site Group were determined to require NFA with annual documentation showing the land use has not changed from what was assumed in the ROD. Land use at all sites have not changed and are not expected to change in the near future. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### 22.6 Issues: 25 Site Group

No issues which effect the protectiveness of the remedy were identified for the 25 Site Group during this FYR.

### 22.7 Recommendations and Follow-up Actions: 25 Site Group

No recommendations or follow-up actions were identified for the 25 Site Group during this FYR.

## **22.8 Protectiveness Statement: 25 Site Group**

The remedy at the 25 Site Group is protective of human health and the environment.

All of the sites within the 25 Site Group require NFA with annual documentation showing the land use has not changed from what was assumed in the ROD. Annual land use inspections have demonstrated that land use has not changed. ICs enforced by the Army, such as land use restrictions, remain active and effective.

## 23.0 21 Site Group (multiple sites)

### 23.1 Background: 21 Site Group

The 21 Site Group (PICA-096), addressed the remedies at 21 sites located in nine areas at Picatinny (**Figure 23-1** through **Figure 23-24**). One site, Site 60, was determined to require NFA, the remaining 20 sites were also determined to require NFA but with Monitoring of Land Use to ensure the land use remains military/industrial. The 21 Site Group, separated by area, consists of the following:

- Area D - Site 69 (**Figure 23-1**), Site 117 (**Figure 23-2**), Site 123 (**Figure 23-3**)
- Area F - Site 60 (**Figure 23-4**), Site 145 (**Figure 23-5**)
- Area G - Site 134 (**Figure 23-6**), Site 136 (**Figure 23-7**), Site 185 (**Figure 23-8**)
- Area J - Site 175 (**Figure 23-9**)
- Area K - Site 172 (**Figure 23-10**), Site 174 (**Figure 23-11**), Site 186 (**Figure 23-12**)
- Area L - Site 176 (**Figure 23-13**), Site 177 (**Figure 23-14** through **Figure 23-17**)
- Area N - Site 10 (**Figure 23-18**)
- Area O - Site 164 (**Figure 23-19**)
- Area P - Site 27 (**Figure 23-20**), Site 119 (**Figure 23-21**), Site 120 (**Figure 23-22**), Site 121 (**Figure 23-23**), PICA-208 (**Figure 23-24**)

The 21 Site Group (PICA-096) has been used for military and industrial purposes. The future land uses planned for most the 21 Site Group will ultimately remain as industrial as specified in the most recent Vision Plan for Picatinny Arsenal.

Descriptions of each of the 21 Site Group sites are included in **Appendix 5**.

#### 23.1.1 Site Chronology

**Table 23-1: Chronology of Site Events at 21 Site Group**

Event	Date
Preliminary Assessments/Site Investigations	1988-1996
Remedial Investigations	1995-1998
Additional Sampling and Focused Remedial Actions	1990-2005
Proposed Plan	2014
Record of Decision	2014

### 23.1.2 Basis for Taking Action

Based on the results of previous site investigations, contaminants were evaluated only for the current and reasonably anticipated future use. An HHRA for the sites included exposure scenarios for the current outdoor maintenance workers, future industry/research workers, and future construction/excavation workers based on site specific concentrations of contaminants which exceeded comparison criteria. Additional qualitative risk evaluations were conducted at some sites at the request of the USEPA to determine if site conditions met the requirements of unrestricted use using current LOCs because either only qualitative risk evaluations were conducted previously or because some data were not included in the previous quantitative risk evaluation due to the availability of more recently collected data. The results of the risk assessment indicated that under the current and hypothetical exposure scenarios, the excess lifetime carcinogenic risk posed by contaminants was within the NCP target range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  and the HI is below 1 for the current land use at each of the 21 sites. No further remedial action was necessary for 20 of the 21 sites; however, as discussed in **Section 4.6**, the Army chose to develop a remedial action for 20 of the sites based on the  $1 \times 10^{-6}$  risk level due to a specific request by the USEPA and the NJDEP to consider a remedial action at these sites.

The concentrations of contaminants at each site which exceeded the LOC can be found on the figures for each site (**Figure 23-1** through **Figure 23-24**).

## 23.2 Remedial Actions: 21 Site Group

### 23.2.1 Remedy Selection

The ROD for the 21 Site Group was signed by the U.S. Army on December 4, 2014 and by the USEPA on March 2, 2015. The selected RA for Sites 10, 27, 69, 117, 119, 120, 121, 123, 134, 136, 145, 164, 172, 174, 175, 176, 177, 185, 186, and 208 was NFA with annual monitoring of land use. Site 60 was determined to be NFA and could be released for unrestricted use.

### 23.2.2 Remedy Implementation

All of the sites in the 21 Site Group were determined to require NFA. Annual inspections occur to verify land use has not changed from military/industrial.

## 23.3 Progress Since Last Five-Year Review: 21 Site Group

This is the first FYR since the 21 Site Group ROD was signed; therefore, no recommendations, issues, or protectiveness statements were made.

Subsequent to the fourth FYR, the Proposed Plan and ROD were submitted and approved by the USEPA. The ROD selected a NFA RA for all of the 21 sites with annual monitoring of land use for all but Site 60. One land use inspection has occurred since the 2014 ROD was signed.

## **23.4 Document and Data Review: 21 Site Group**

### **23.4.1 Document Review**

Relevant and appropriate documents associated with the 21 Site Group (PICA-096) investigations, remedy development, and operations were reviewed for this Fifth FYR report. Key documents reviewed for this FYR can be found in **Section 3.5**. Site-specific documents reviewed include:

U.S. Army, 2014a. Final No Further Action with Monitoring of Land Use Proposed Plan for 26 Sites. May.

U.S. Army, 2014b. Record of Decision for 21 Site Group. November.

### **23.4.2 Data Review and Evaluation**

Chemical data are not collected as part of the remedy at the 21 Site Group. Annual inspections are conducted to verify no changes in land use have occurred.

## **23.5 Technical Assessment: 21 Site Group**

### **23.5.1 Question A**

*Is the remedy functioning as intended by the decision documents?*

Yes.

#### **23.5.1.1 Remedial Action Performance**

The selected remedy for the 21 Site Group is NFA for all 21 sites with Site Monitoring for 20 of the sites. The 2015 inspection has occurred and verified no changes in land use have occurred. The selected remedy is functioning as intended by the 2014 ROD.

#### **23.5.1.2 Operations and Maintenance**

Annual inspections are only required to document the land use, no further maintenance is required at the sites.

#### **23.5.1.3 Opportunities for Optimization**

No opportunities for optimization were identified during this FYR.

#### **23.5.1.4 Early Indicators of Potential Issues**

No early indicators of potential issues were identified during this FYR.

#### **23.5.1.5 Implementation of Land Use Controls and Other Measures**

The 21 Site Group was determined to require NFA at all sites; LUCs were not a part of the selected remedy. The annual inspections performed document the land use has not differed from what was assumed in the ROD.

#### 23.5.2 Question B

*Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?*

Yes. The 21 Site Group was determined to require NFA at all sites; LUCs were not a part of the selected remedy and no RAOs were formalized in the ROD. All but one of the sites require annual documentation showing the land use has not changed from what was assumed in the ROD. The annual inspections documented the land use has not differed from what was assumed in the ROD. The exposure assumptions, toxicity data, and RAOs remain valid because the land use has not changed at the sites.

#### 23.5.3 Question C

Has any other information come to light that could call into question the protectiveness of the remedy?

No.

##### 23.5.3.1 Ecological Risks

No information regarding possible ecological risks has come to light that could call the protectiveness of the remedy into question.

##### 23.5.3.2 Natural Disasters

No natural disasters have occurred that call the protectiveness of the remedy into question.

##### 23.5.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

No other information has been found that could call into question the protectiveness of the remedy.

#### 23.5.4 Summary of Technical Assessment

All of the sites within the 21 Site Group were determined to require NFA with annual documentation showing the land use has not changed from what was assumed in the ROD. Land use at all sites have not changed and are not expected to change in the near future. Exposure assumptions made in the ROD remain valid and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy. Exposure assumptions made in the ROD remain valid, and no changes to risk assessment, toxicity data, or cleanup levels have occurred which impact the protectiveness of the remedy.

### 23.6 Issues: 21 Site Group

No issues which effect the protectiveness of the remedy were identified for the 21 Site Group during this FYR.

### 23.7 Recommendations and Follow-up Actions: 21 Site Group

No recommendations or follow-up actions were identified for the 21 Site Group during this FYR.



### **23.8 Protectiveness Statement: 21 Site Group**

The remedy at the 21 Site Group (PICA-096) is protective of human health and the environment.

All of the sites within the 21 Site Group require NFA with annual documentation showing the land use has not changed from what was assumed in the ROD. Annual land use inspections have demonstrated that land use has not changed. ICs enforced by the Army, such as land use restrictions, remain active and effective.

## **24.0 Next Review**

The next FYR is due September 2021, five years from the date of this review.

## 25.0 References

All references for site-specific documents are included within their respective sections. Additional documents referenced in this document include:

AECOM Joint Venture, 2015. Picatinny Arsenal Real Property Vision Plan. November.

United States Environmental Protection Agency, 2001. Comprehensive Five-Year Review Guidance, OSWER Directive 9355.7-03B-P. June.

United States Environmental Protection Agency, 2010. Interim Final Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites (OSWER 9355.0-89, EPA 540-F-00-005)

United States Environmental Protection Agency, 2011. Enforcing Five-Year Review Requirements under Federal Facility Requirements. Memorandum. July 21

United States Environmental Protection Agency 2011. Program Priorities for Federal Facility Five-Year Review. Memorandum to Superfund National Policy Managers Regions 1-10. August 1.

United States Environmental Protection Agency, 2011. Recommended Evaluation of Institutional Controls: Supplement to the "Comprehensive Five-Year Review Guidance," OSWER Directive 9355.7-18. September.

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United States Environmental Protection Agency, 2012b. Memorandum to National Superfund Program Managers: Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation and Liability Act Five-Year Reviews. September 23.

United States Environmental Protection Agency, 2012c. Assessing Protectiveness at Sites for Vapor Intrusion Supplement to the "Comprehensive Five-Year Review Guidance" OSWER Directive 9200.2-84. November.

United States Environmental Protection Agency, 2015a. Ground Water Technical Considerations during the Five-Year Review Process. EPA-542-F-15-010. April.

United States Environmental Protection Agency, 2015b. Office of Solid Waste and Emergency Response (OSWER) Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. OSWER Publication 9200.2-154. June.

United States Environmental Protection Agency, 2015c. Regional Screening Levels. November.